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Notes on Some Indian Ustilagineae—I

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1. Chlamydospore Germination in Tilletia tumefaciens Syd.

Tilletia tumefaciens Syd. is a remarkable gall forming smut on *Panicum antidotale* Retz. in North India. The smut attacks the young axillary buds at the base of the plants converting them into large smut galls. A detailed account of the smut sori development and the structure of the spore is given by Mundkur (1944). When viable spore material became available for studying chlamydospore germination, the chlamydospores were germinated and stained according to the method previously outlined by the writer (1940) for teliospores.

The chlamydospores germinated sixty hours after being placed in moist chambers at room temperature (20–24 c.). The stout, cylindric promycelium emerges after cracking the spore coat. The syncaryotic nucleus migrates into the promycelium (Fig. 1) and undergoes successive divisions (Fig. 2) resulting in as many as 10 to 16 nuclei. The promycelium elongates rapidly and the protoplasmic contents move upwards. The empty basal portions of the promycelium may be separated off by one or more septa.

The initials of the sporidia are first formed as small papillate projections (Figs. 3 and 4), into which a single nucleus migrates from the promycelium. The sporidia are 8–12 in number, filiform, straight or slightly arcuate. They begin to conjugate in pairs *in situ* soon after their formation. The conjugation branches develop laterally and the sporidia at this stage look like forked structures (Fig. 5).

In some cases more than one conjugation tube is formed by each sporidium. The conjugation tubes of two sporidia (possibly compatible ones) meet and initiate dicaryophase (Fig. 6). Soon after conjugation, the crown of sporidia slips out of the promycelium. After the initiation of the dicaryophase, long and slender infection hyphae are formed. The formation of secondary sporidia has not been observed.

Because the development of the sorus of *Tilletia tumefaciens* takes place in axillary buds, Mundkur (1944) objected to Ciferri's view (1933) that the genus *Tilletia* be limited to ovaricolous smuts, and that all

smuts attacking leaves and culms be regarded as belonging to *Ustilago*. For in addition to the structure of the spores, the type of chlamydospore germination observed in the present study reveals that the smut is a species of *Tilletia*.

2. TILLETIA NARAYANARAOANA MUNDKUR AND THIRUM.

Tilletia Narayanaraoana was described by Mundkur and Thirumalacher (1949) as an ovaricolous smut on *Panicum trypheron* Schultz. collected by the writer near Bangalore, South India. The smut attacks only few florets in the inflorescence appearing like a flower-infecting smut. The chlamydospores are black in mass and associated with sterile cells. Under the microscope the chlamydospores are brownish-black, with spathulate scale-like warts on the exospore. There is no hyaline sheath for the spores.

The chlamydospores were germinated and stained as in the previous case. The promycelium emerged eighty hours after the spores were placed in moist chambers. The stages of sporidial formation and their conjugation are similar to those of *Tilletia tumefaciens* (Figs. 7 and 8). The sporidia number 10–16 and each of them develops one or two conjugation branches which impart a spicule-like appearance to the sporidia (Fig. 9).. The dicaryophase begins after sporidial conjugation.

These spicule-like conjugation branches of the sporidia are interesting because they resemble spicular structures illustrated for the sporidia of *Glomosporium* by Kochman (Zundel 1943). A careful analysis of Kochman's illustrations indicates that these spicules are not ornamental but rather early stages of conjugation branches. A comparison of similar structures of *Tilletia Narayanaraoana* and *T. tumefaciens* illustrates the point. Spicules and other types of ornamentations are usually found only in resting spore types.

3. FARYSIA RACIB.

The genus *Farysia* was established by Raciborski (1909) for an ovaricolous smut occurring on Cyperaceae in Java. The presence of an agglutinated spore mass covered by a false membrane of fungal tissue and numerous parallel elaters traversing the spore mass are important diagnostic characters. Earlier workers like Berkeley (1836) mistook the elaters for shredded host tissue. Bubak (1912) also came to the same conclusion about the nature of the elaters. Brefeld (1883), Fischer (1920), Liro (1938) and Ciferri (1938) pointed out that the elater-like strands are wholly composed of sterile hyphal bundles.

The known species of *Farysia* are ovaricolous smuts on Cyperaceae. Sydow included also *Farysia emodensis* (Berk.) Syd., a gall forming smut on the inflorescence of *Polygonum chinense*. This smut has been shown to belong to a separate genus, *Liroa* Ciferri, possessing characters quite different from those of *Farysia*.

Three species of *Farysia*, *F. Butleri* (Syd.) Syd., *F. olivacea* (DC.) Syd. and *F. pseudocyperi* (deToni) Zundel, occur in India and were available for study. Thus the structure of the sorus could be restudied in the hope of finding relationships with other members of the Ustilaginaceae.

FIGS. 1 to 6. *Tilletia tumefaciens*. 1–4. Germination stages of the chlamydospore, × 500. 5. Development of the conjugation branches, × 500. 6. Sporidial conjugation, × 1000.

FIGS. 7 to 9. *Tilletia Narayanaraoana*. 7 and 8. Germination of chlamydospores, × 750. 9. Mature sporidium showing spicular-like conjugation branches, × 1500.

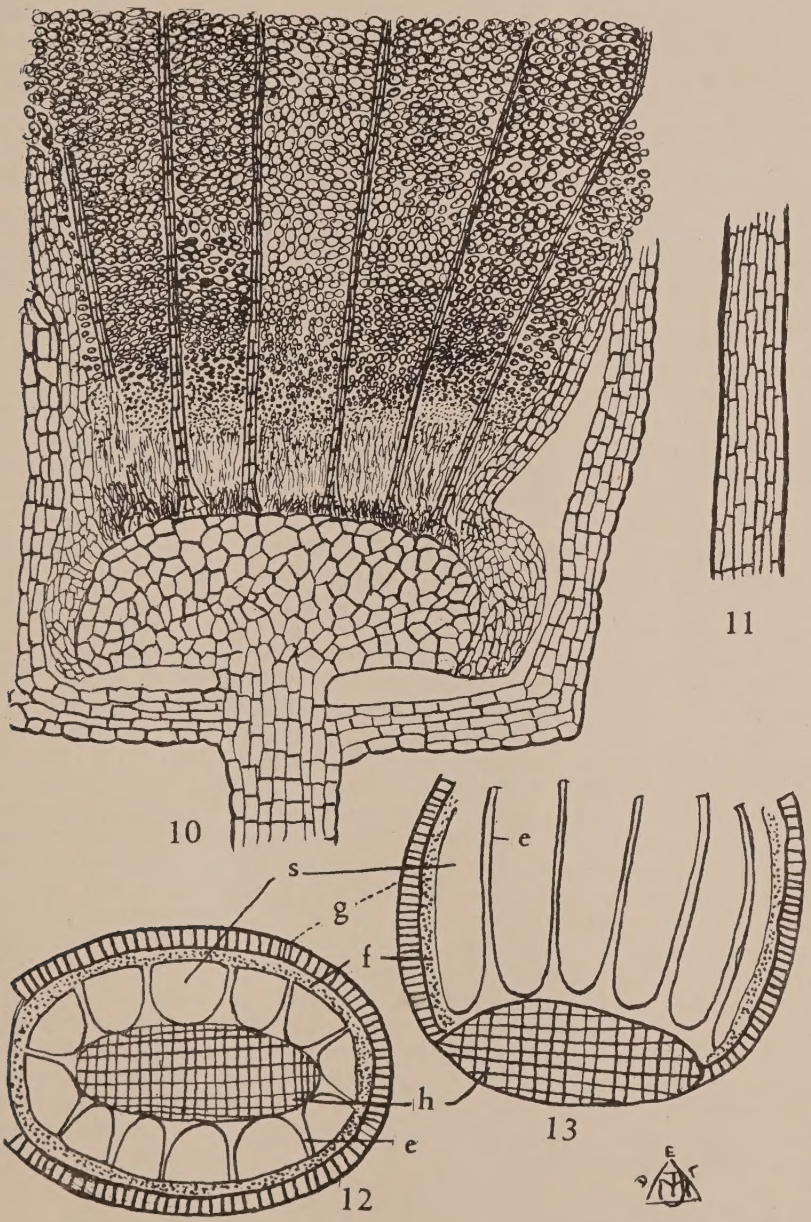
For microscopic study, the herbarium material was softened and sectioned with a microtome. The sections were stained with an aqueous solution of congo red and light-green in clove oil. Staining with congo red brought out the fungus tissues very clearly, while the host tissues were stained light green.

Observations on the sorus structure confirmed the findings of Fischer (1920), Ciferri (1938) and Liro (1938). The glumes of the spikelet form the outermost envelope. Next to that, a layer of sterile spores constitutes the false membrane. There is a central mound of host tissue approximately corresponding to the thalamus of the flower, on which there is a stromatic mass of hyphae. This stromatic mass alternately differentiates strands of sterile and fertile hyphae (Fig. 10). The sterile hyphae are at first thin-walled, but later become thick-walled and brown, appearing as long strands (Fig. 11). The fertile hyphae produce in basipetal succession chlamydospores following gelatinization of the hyphae. In a longitudinal section of the sorus, the different stages of the development of the elaters and spores can be followed.

A comparative study indicated a similar situation in *Cintractia* Cornu, forming sori in the ovaries and peduncles of Cyperaceae. When the smut is ovaricolous, the sori of *Cintractia* have an outermost envelope of the host glume, followed by the false membrane of fungal tissue. If the central mound of the host tissue is taken as the axis, the development of the sorus in *Farysia* is restricted to the terminal apex, while in *Cintractia* it is lateral, surrounding the host axis. The result is that in *Farysia* the host tissue appears like a mound of tissue at the base of the sorus, while in *Cintractia* the host tissue forms a central core, usually termed columella. In *Cintractia* the stromatic mass is formed around the host axis in the same manner as in *Farysia*, alternately differentiating sterile and fertile strands of hyphae, the latter producing spores in basipetal succession. The only difference is that the sterile strands of hyphae are not well enough developed to form the shred-like elaters so characteristic of *Farysia*. If one takes a conservative view of the structure of the sorus and spores as the basis for classification, there is little difference between *Farysia* and *Cintractia* except for the plane of sori formation (Figs. 12 and 13). Fischer's view that *Farysia* and *Graphiola* (which is included in Fungi Imperfecti by some mycologists) may be related is not tenable. For taxonomic purposes it is best to keep *Cintractia* and *Farysia* separate, the latter to include ovaricolous smuts showing conspicuous elater-like structures traversing the sori, which at maturity protrude and expose the spores to wind dispersal.

4. Ustilaginoidea Burkillii (Syd. & Butler) Thirum. and Mundkur

Sydow and Butler (1912) described *Ustilago Burkillii* as a flower smut on *Aneilema nodiflora*, a member of the Commelinaceae. The fungus was collected by I. H. Burkill near Gauripur, Mymensingh, India, and is the only collection so far known in this country. Sydow and Petrak (1928) recorded this fungus from the Philippines on *Aneilema malabaricum*. A second collection of this fungus was made by the



FIGS. 10, 11 & 13. *Farysia olivacea*. 10. Longitudinal section through sorus, × 200. 11. Elater-like strand, × 1000. 12. Diagramatic sketch of sorus of *Cintractia*. g—host glumes, f—false membrane, h—host tissue, s—spores, e—sterile strands of hyphae. 13. Same as *Farysia* with corresponding description.

writer near Bangalore and this enabled him to restudy the fungus in some detail, with the result that it is not a species of *Ustilago*.

The fungus was described as ovaricolous, the spores measuring 9 to 15 μ with a mean of 12.4 μ. Comparison with the type material of *Ustilago Burkillii* deposited in the Herb. Crypt. Ind. Orient., New Delhi, proved that the Bangalore specimen was identical with that collected by Burkill. Mundkur (1939) pointed out that the spores are pitted and not smooth as described by Sydow and Butler.

Microscopic examination of the microtome sections of the infected flower revealed that the fungus is not ovaricolous, but parasitizes the filament of the stamens and the inner perianth, producing large masses of powdery yellow spores which fill the space between the floral parts. In the anthers the microspores develop to a certain stage but abort later, possibly due to damage inflicted on the filaments (Fig. 15).

The mycelium completely fills the host cells and protrudes in form of long threads. The hyphae are septate and develop laterally numerous spores (Fig. 14). Gelatinization of the hyphae and the dicaryophase so characteristic of the smuts are lacking. In old sori the spores are associated with the fragments of hyphae on which they were developed (Figs. 16 and 17).

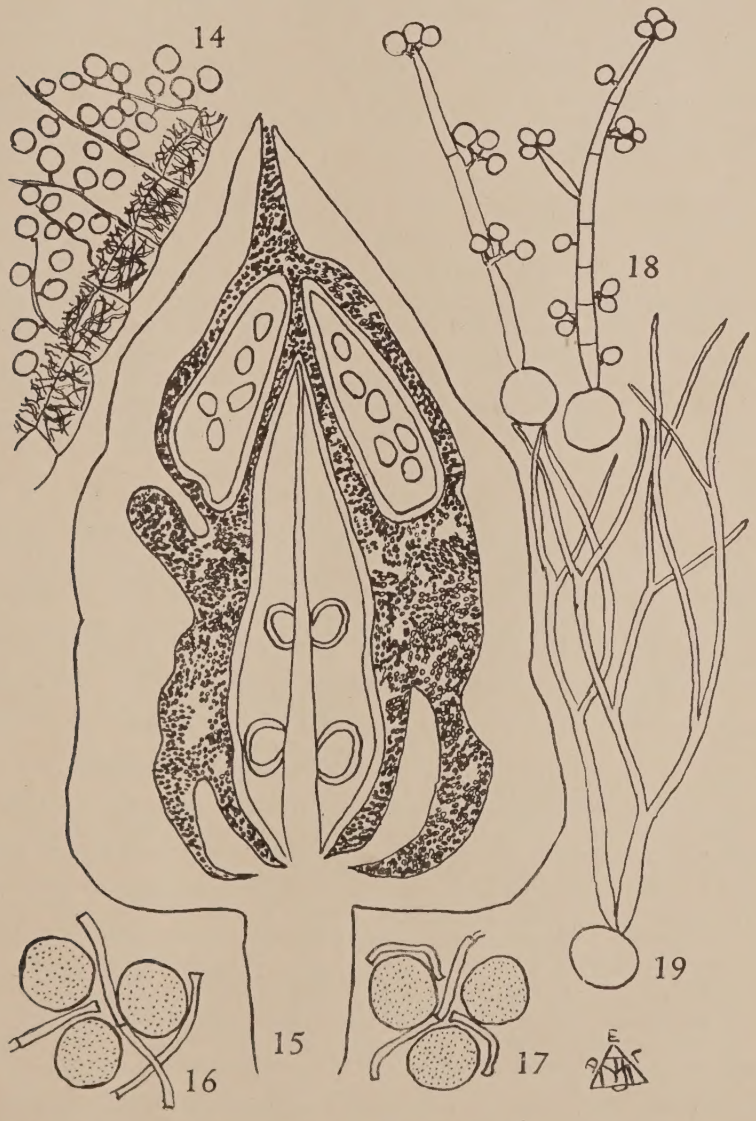
The spores germinate readily in water and develop one or more long, branched germ tubes. There is no structure comparable to a promycelium. Each cell of the septate germ tube shows a single nucleus and develops one to four conidia in clusters on short hyphae (Fig. 18). When the spores are completely submerged, no conidia are produced, although there is an extensive development of branched hyphae. The behavior of the conidia produced by germ tubes was not observed.

The mode of development of spores on hyphae and spore germination indicate that the fungus is not referable to *Ustilago*, but a species of *Ustilaginoidea* Bref. *Ustilaginoidea virens* (Cke.) Tak., known as the false smut of rice and originally mistaken for a smut, was described under the name *Ustilago virens* Cke. The spores are produced pleurogenously on radiating hyphae on short stalks. After germination, the spores produce slender septate hyphae which form clusters of hyaline conidia in the same manner as described for the fungus inhabiting *Aneilema nodiflora*. Brefeld studied the fungus in some detail while in artificial culture. *Ustilaginoidea Setariae* develops sclerotia which after germination produce perithecia on stroma. Gäumann and Dodge (1928) regard *Ustilaginoidea* and *Claviceps* as closely related. Although sclerotial development has not been observed in the fungus of *Aneilema*, its spore formation and spore germination indicate that the fungus is a species of *Ustilaginoidea*. On this basis the following change in its name is proposed: **Ustilaginoidea Burkillii** (Syd. & Butler) Thirum. and Mundkur, comb. nov.

5. TWO OVARICOLOUS SMUTS ON ISEILMA LAXUM Hack.

Ustilago Inayati was described by Sydow and Butler (1912) from material found in spikelets of *Iseilema laxum* and collected in U. P. India, by Inayat Kahn. Another collection of this ovaricolous smut on the same host from Samalkota, Madras, S. India, was referred to a new species by Sydow and Butler (1912), *Ustilago Iseilemantis*.

The differences in size and sculpturing of their spores were the differentiating characters. Both smuts were collected again in Mysore by the writer. Study of the types of *U. Inayati* and *U. Iseilematis* revealed that they were species of *Sphacelotheca*, necessitating their redescription.



FIGS. 14 to 19. *Ustilaginoidea Burkillii*. 14. Development of hyphae and spores, × 200. 15. Longisection of infected flower of *Aneilema nodiflora*, × 80. 16 and 17. Mature spores, × 750. 18. Germinating spores with conidia, × 500. 19. Germination of submerged spore, × 750.

Sphacelotheca Inayati (Syd. & Butler) Mundkur & Thirum., comb. nov.

Sori in ovaries, all ovaries in inflorescence attacked, causing slight deformity due to shortening of internodes and presenting a bunchy appearance, covered by a pseudomembrane; pseudomembrane flaking away at maturity, and disclosing a black spore mass and a simple or forked columella; sterile cells pale-yellowish-brown, measuring 12.5–15 μ. in diam. Spores subglobose to spherical, densely echinulate, brownish-yellow, 8 to 12 μ. with a mean of 10.5 μ. Hab. in ovaries of *Iseilema laxum* Hack., Orai, U. P., leg. Inayat Khan and Paduvigere, Mysore, leg. M. J. Thirumalachar.

Sphacelotheca Iseilematis (Syd. & Butler) Mundkur & Thirum., comb. nov.

Sori in ovaries, all ovaries in inflorescence attacked, covered by persistent glumes and a pseudomembrane; membrane flaking away at maturity and exposing the black spore mass and a simple or forked columella; sterile cells pale-yellow, 9–17 μ. in diam. Spores globose to ellipsoid, slightly angular, olive-brown, smooth, 6–7 μ. in diam. Hab. in ovaries of *Iseilema laxum* Hack., Samalkota, Madras, leg. C. A. Barner, and Goribidanur, Mysore, leg. M. J. Thirumalachar.

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Notes on Some Indian Ustilagineae—II

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Sphacelotheca Saccolepidis Thirumalachar, sp. nov.

Sori ovaricolous, destroying all ovaries in the inflorescence, covered by the persistent glumes and a cinnamon-yellow pseudomembrane which flakes away at maturity exposing the black spore mass and a simple persistent columella; sterile cells in the membrane firm, rectangular, pale cinnamon-yellow, 7–10 x 4.5–8 μ. Spores reddish-brown, subglobose to spherical, 10–13 μ. in diameter with a mean of 11.3 μ.; epispore densely covered with short echinulations.

Hab. In the ovaries of *Saccolepis indica* Chase. (=*Panicum indicum* L.) Bhadravati, Mysore, 18–8–1947, leg. H. C. Govindu, (TYPE).

Sori ovaricoli, omnia ovaria inflorescentiae degenerata producentes, glumis persistentibus et pseudomembrana cinnamomeo-lutea matura decorticante exposita nigram sporarum massulam atque simplicem columellam persistentem expositam involucrati. Membranae steriles cellulae firmae, rectangulares, pallide cinnamomëo-luteae, 7–10 x 4.5–8 μ.; sporae rubro-brunneae, subglobosae vel sphericae, (10)–11.3–(13) μ.; episporium dense echinatum.

Hab. In ovariis *Saccolepis indicae* Chase. (Figs. 1 to 4).

Sphacelotheca Fagopyri Syd. & Butler, Ann. Mycol. **5**: 486, 1907.

Hab. In the ovaries of *Fagopyrum esculentum* Moensch., Mercara, Coorg, South India, 8–2–1947, leg. M. J. Narasimhan; Ootacamund, 16–4–1946, leg. H. C. Govindu. The only previous record of this fungus was from Kulu, Himalayas (Butler & Bisby 1931).

Cintractia Scleriae-lithospermi Thirumalachar, sp. nov.

Sori in ovaries, completely destroying them and partly hidden by the enveloping glumes, 3 to 4 mm. in diameter, replacing the large bony seed by a semi-agglutinated spore mass; columella very inconspicuous and not protruding. Spore mass at first covered by a whitish enveloping membrane which soon flakes away; spores ovate to polygonal, reddish-brown, 14–17.5 μ. in diameter, with a mean of 15.5 μ., smooth or appearing indistinctly tuberculate under high magnification. Epispore ridged into wing-like structures at opposite ends.

Hab. In the ovaries of *Scleria lithospermi* SW. var. *Roxburghii* Thw. Lakkavalli, Mysore, 15–8–1945, leg. M. J. Thirumalachar, (TYPE).

Sori in ovariis degeneratis, glumis partim involucratis, 3–4 mm. in diam., seminibus magnis osseis in semi-agglutinatam sporarum massulam mutatis; columella inconspicua atque haud protrusa. Sporarum massula albido-involucrata, demum decorticans; sporae ovatae vel polygonales, rubro-brunneae, (14)–15.5–(17.5) μ., laeves vel indistincte tuberculatae. Episporium bialatum.

Hab. In ovariis *Scleriae lithospermi* SW. var. *Roxburghii* Thw. (Figs. 5 to 7).

Scleria lithospermi var. *Roxburghii* is a common sedge abundantly present in the marshes surrounding the rice fields. The seeds are large, whitish and of conspicuous bony appearance. In smutted plants, all ovaries are parasitized, and converted into black semi-agglutinated spore masses. The characteristic wing-like structure produced by the extension of the exospore and other characters indicate that this smut is an undescribed species of *Cintractia*.

FARYSIA CARICIS-FILICINAE S. Ito, Trans. Sapporo Nat. Hist. Soc. **14**: 91, 1935.

Farysia pseudocyperi (de Toni) Zundel, Mycologia **23**: 297, 1931.

Hab. On *Carex condensata* Nees (not 'baccans'), collected by Hooker in East Nepal (Tambur River) before 1854, and in Khasi Hills by Hooker and Thompson.

The smut on *Carex condensata* in India was placed in *Farysia pseudocyperi* by Mundkur (1940). In a recent paper Ling (1949) has given reasons for rejecting the specific name '*pseudocyperi*' as a *nomen ambiguum* and recognizing the later described specific name '*Caricis-filicinae*' as the correct one. The spore measurements given by Ling from the type of *F. Caricis-filicinae* are 5.36 to 10.05 μ. in diameter with a mean of 7.6 μ. and those given by Mundkur for the two collections of the smut made by Hooker are as follows:

(a) East Nepal specimen, 6–10.3 μ. with a mean of 7.7 μ.
(b) Khasi Hills specimen, 6–9.6 μ. with a mean of 7.7 μ.

It is therefore evident that the Indian collections closely agree with those of the type of *F. Caricis-filicinae*.

FARYSIA AMERICANA Ciferri, Ann. Mycol. **29**: 73, 1931.

Hab. In ovaries of *Carex filicina* Nees, Kemmangundi, Mysore, 26–4–1949, leg. M. J. Thirumalachar.

Collections of this smut of *Carex filicina* are of interest since the type of *F. Caricis-filicinae* Ito was described from the same host species in Formosa. However, when spore measurements are considered, only slight differences are found. Actually the collections of this smut made in Mysore resemble more closely those of *F. americana* described by Ciferri from North America.

Farysia americana (Mysore collections)

Diam. (μ)	4.5	5.4	6.2	7	8	8.5	9.3	
Frequency	14	14	22	20	22	6	2	—100

Mean 6.6 μ.

Farysia americana (measurements given by Ciferri for the type)

Diam. (μ)	4	5	6	7	8	9	10	
Frequency	5	41	93	31	17	8	5	—200

Mean 6.2 μ.

Farysia Caricis-filicinae Ito (given by Ling for the type)

Diam. (μ)	5.36	6.03	6.70	7.37	8.04	8.71	9.38	10.05	
Frequency	1	2	24	29	31	6	4	3	—100

Mean 7.61 μ

The differences in spore measurements are so slight that study of large-scale collections may prove these two species to be the same.

Sorosporium Iseilematis Thirumalachar, sp. nov.

Sori destroying all ovaries in the inflorescence, causing stunted growth and shortened internodes, resulting in 'witches brooms,' 10–15 mm. long, covered by persistent glumes and greyish-yellow

FIGS. 1–10. 1. Smutted inflorescence of *Saccolepis indica*, × 2. 2. Enlarged view of smutted spikelet, × 6. 3 and 4. Chlamydospores of *Sphacelotheca Saccolepidis*, × 1080. 5. Smutted spikelets of *Scleria lithospermi*, × 3.5. 6. Showing the healthy plant, × 3.5. 7. Chlamydospores of *Cintractia Scleriae lithospermi*, × 900. 8. Smutted spikelets of *Iseilema laxum*, × 1.2. 9. Portion of the spore ball *Sorosporium Iseilematis*, × 600. 10. Inner spores of the same showing the polygonal nature, × 1200.

pseudomembrane which flakes away at maturity, exposing the black somewhat agglutinated spore mass; sterile cells cinnamon-yellow, rectangular, 6–13 x 6–12.5 μ. Columella simple and inconspicuous; spore balls semipermanent, black, ovate to rectangular, 112 to 200 x 84–168 μ; outer spores reddish-brown, verruculose, inner spores pale cinnamon-yellow, polygonal, smooth, 8–11.5 x 7–77 μ.

Hab. In ovaries of *Iseilema laxum* Hack., Nandi Hills, Mysore, 28–11–1949, leg. M. J. Thirumalachar (TYPE).

Sori ovaria omnia in inflorescentia degenerata atque internodia abbreviata deformia (witches bloom) producentes, 10–15 mm. longi, glumis persistentibus atque pseudomembrana luteo-brunnea matura decorticante sporarum massulam nigram aliquantum agglutinatam expositam inclusi; cellulae steriles cinnamomeo-luteae, rectangulares, 6–13 x 6–12 μ.; columella simplex atque inconspicua. Sporarum massulae semipermanentes, nigrae, ovatae vel rectangulares, 112–200 x 84–168 μ. Sporae exteriores rubro-brunneae, verruculosae; interiores vero cinnamomeo-luteae, laeves, polygonales, 8–11.5 x 7–11 μ.

Hab. In ovariis *Iseilematis laxi* Hack. (Figs. 8 to 10).

The smut incites systemic infection either in portions of or entire plants. In infected plants the leaves are stiff and upturned, and the internodes are short, imparting a witches broom appearance.

Pericladium Tiliacearum Mundkur & Thirumalachar, sp. nov.

Sori in stems and petioles, covered by the host tissue, appearing as blister-like pustules and on degeneration of the host tissue exposed as black spore masses; sori two to three locular due to the confluence of pustules. Spores globose to subspherical, slightly angular, yellowish-brown, 5 to 7 μ in diameter with a mean of 6.3 μ. Promycelium one to two-septate, bearing a single terminal sporidium.

Hab. On stems and petioles of *Grewia rotundifolia* Juss. Channapatna, Mysore, 23–11–1943, leg. K. B. A. Kahn (TYPE), *Grewia tiliaefolia* Vahl., Santaveri, Mysore, 24–10–1943, leg. M. J. Thirumalachar.

Sori caulibus atque petiolis inclusi pustulas tumidulas formantes, 2 vel 3- loculares; ultimum ut nigrae sporarum massulae commutati; sporae globosae vel subsphericae, tenuiter angulares, brunneo-luteae, (5)–6.3–(7) μ diam. Promycelium 1 vel 2-septatum, unum sporidium terminale gerens.

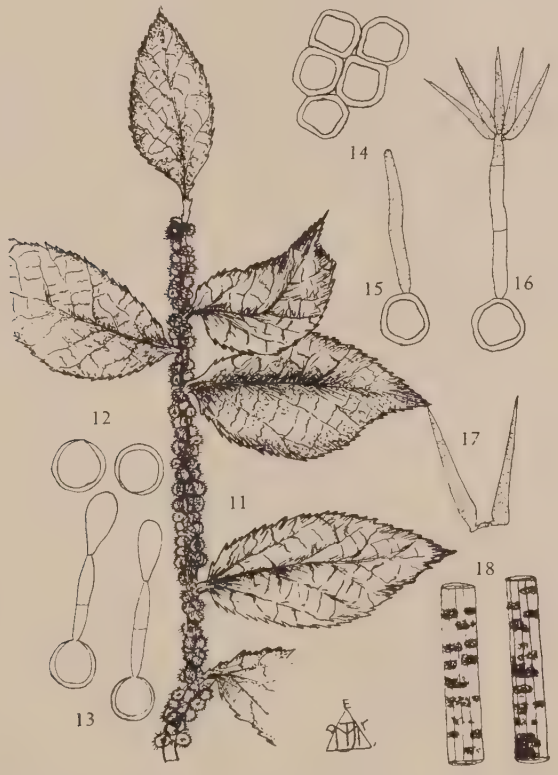
Hab. in ramis *Grewiae rotundifoliae* Juss. et *G. tiliaefoliae* Vahl. (Figs. 11 to 13).

The genus *Pericladium* was proposed by Passerini (1875) for a fungus on *Grewia*, regarded by him as a rust, but actually a smut. *Pericladium Grewiae* Pass. which is the type of the genus has been recorded for India by Mundkur (1944) based on material collected by R. R. and I. D. Stewart. Mundkur also pointed out that *Xylosorium* described by Zundel (1939) for a similar gall forming smut on *Piper* in Africa, is synonymous with *Pericladium*. Smut galls appearing as tuberculate warts on the stems with locular sori and enveloped by thick layers of host tissue are the chief characters of the genus.

Collections of a smut with similar characters were made in several places in Mysore, and these made possible a detailed study of the fungus. Microtome sections through young sori indicate that the mycelium first gets concentrated in the cortical tissue where the initials of the young sori are formed. Gradually the surrounding cortical cells break down leaving a small lacuna filled with hyphal strands. Centripetally chlamydospores are produced in large numbers. The cortical cells surrounding the sorus multiply rapidly and thus incite the formation of

a gall-like outgrowth. The stellate indumentum which forms a dense felt on the leaves and shoots, is also present on the gall.

The chlamydospores were germinated and stained according to the method suggested by the writer (1940). The promycelium is one to two-septate, bearing a single terminal, obovate sporidium. The nuclear cycle involved in the formation of the sporidium was not observed.



FIGS. 11–18. 11. Infected plant of *Grewia tiliaefolia*, slightly reduced. 12. Chlamydospores of *Pericladium Grewiae*, × 1200. 13. Germinating chlamydospores of the same, × 1200. 14. Chlamydospores of *Entyloma mysorense*, × 600. 15 and 16. Germinating chlamydospores of the same, × 600. 17. Sporidial conjugation, × 900. 18. Showing the infected stems of *Scirpus* sp. by *Entyloma mysorense*, slightly reduced.

Entyloma mysorense Thirumalachar, sp. nov.

Sori in stems, forming small irregular dark, diffuse areas up to 5 mm. in diameter, non-erumpent; spores cinnamon-brown, densely grouped in the intercellular spaces, subglobose to spherical, 7.8–11 μ. in diameter with a mean of 9 μ. Spores germinating by a promycelium bearing a terminal whorl of sporidia which conjugate immediately in pairs.

Hab. In the stems of *Scirpus* sp., Anandapuram, Sagar, 15–8–1947, leg. M. J. Narasimhan (TYPE).

Sori in culmis minutas regiones irregulares diffusas formantes, ad 5 mm. diam., non-erumpentes. Sporae cinnamomeo-brunneae, dense aggregatae in spatiis intercellularibus, subglobosae vel sphaericae, (7.8)–9–(11) μ. diam. Sporae germinantes promycelium 6–8 sporidiis terminalibus verticillatis pari-conjugentibus producentes.

Hab. In ramis *Scirpi* sp. (Figs. 14 to 18).

Collections of this *Entyloma* species were made by Narasimhan near a pond in Anandapuram, Mysore. Comparison of this smut with *Entyloma scirpicola* Thirumalachar & Dickson reported on the same host genus in Mysore indicated that the two are different. *E. scirpicola* has slightly larger chlamydospores and septate sporidia, absent in *E. mysorense*.

DOASSANSIA OPACA Setchell, Proc. Amer. Acad. Arts and Sci. **26**:15, 1891.

Hab. On the leaves of *Sagittaria* sp., Closepet, Mysore, 8–8–1947, leg. M. J. Narasimhan.

This species has not been reported previously for India. The chlamydospores germinate readily when teased out of the spore balls and placed on slides. The promycelium bears a terminal whorl of 5 to 8 sporidia, which in turn develop a cluster of secondary sporidia.

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Development of the Female Gametophyte and Endosperm in Bacopa Hamiltoniana

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INTRODUCTION

Several embryological studies in the Scrophulariaceae yielded notable results and attracted attention because of the interesting and varied types of endosperm development found in this family. While Iyengar (1947) and Srinivasan (1940) studied several South Indian members of the Scrophulariaceae in this respect, Srinath (1940) investigated megasporogenesis and endosperm formation in *Bacopa Monniera* (L.) Pennell (=*Herpestis monnieria* H. B. K.). The present paper is an account of the gametogenesis and endosperm formation in another species of *Bacopa* collected in Ootacamund, South India.

MATERIAL AND METHODS

Bacopa Hamiltoniana (Benth.) Wettst. is a prostrate herb growing in marshy regions along the slopes of the Ootacamund Hills, at an elevation of 7,000 feet above sea-level. The flowers are solitary and pinkish in color. Material for the present investigation was fixed in formalin-acetic alcohol. Microtome sections of 10–18 μ thickness were cut and stained with Heidenhein's iron-alum haematoxylin with orange G or eosin B in clove oil as counterstain.

ORGANOGENY OF THE FLOWER

Sections through young flower buds revealed the sequence of development of the floral organs as follows: sepals, stamens, petals, and carpels. This is in conformity with the observations made by Srinath (1940) in *Herpestis* and Iyengar (1940c) in *Sopubia trifida*.

OVARY AND OVULES

The ovary in *Bacopa Hamiltoniana* is superior, bicarpellary and bilocular with many unitegmic anatropous ovules attached to a massive axile placenta (Fig. 1).

DEVELOPMENT OF THE FEMALE GAMETOPHYTE

The hypodermal archesporium is organised even before the differentiation of the integument (Fig. 2). This feature has been noticed in several members of the Scrophulariaceae by Srinath (1940) and Iyengar (1947). No parietal cell formation occurred and the archesporium directly functioned as the megaspore mother cell (Fig. 3). Following the differentiation of a massive integument the megaspore mother cell elongated rapidly and underwent two successive divisions, the first being meiotic. After wall formation a linear tetrad of megaspores was formed (Fig. 4). In one instance a T-shaped tetrad was seen (Fig. 5).

The chalazal megaspore enlarged and developed into the mature embryo sac (Figs. 6, 7 and 8). In this process the nucleus underwent

three successive divisions and formed an eight nucleate embryo sac as in the *Polygonum* type of Maheshwari (1948). At about the two nucleate stage of the embryo sac the nucellar epidermis was completely disorganized (Fig. 6). A similar condition was reported by Iyengar (1940c) in *Sopubia trifida* Ham. As a result of the early disintegration of the nucellar epidermis the innermost layer of the integument enlarged rapidly and became arranged on either side of the embryo sac forming the endothelium. The cells of the latter were filled with densely staining cell contents and perhaps functioned as the nutritive layer. The endothelium in *Bacopa Hamiltoniana* invested the embryo sac only partially, the antipodal and the micropylar ends being free. This condition is similar to the cases reported by Iyengar (1937 and 1939b) and Srinath (1940).

The mature embryo sac (Fig. 9) was found to be broad at the center and tapered at either ends. The synergids were elongated and the egg was somewhat pyriform in shape. The fusion of the two polars took place in the upper region of the embryo sac. The antipodals were organized as definite cells and degenerated soon after the organization of the egg apparatus. But in the allied species *B. Monnieri*, Srinath (1940) reported the persistance of the antipodals until the early stages of the endosperm formation. Starch grains were usually present in the mature embryo sac (Fig. 9) and these were observed conspicuously in the stained preparations. Iyengar reported the presence of starch grains in the embryo sacs of *Vandellia hirsuta* Ham. (1940a), *Isoplexis canariensis* Lindl. (1939a) and *Stemodia viscosa* Roxb. (1939b).

ENDOSPERM

The primary endosperm divided by a transverse wall forming two chambers (Fig. 11), of which the micropylar was smaller. This type of transverse division of the primary endosperm nucleus is a common feature in all Scrophulariaceae so far investigated (Iyengar, 1947). The nucleus of the micropylar chamber divided, followed by vertical wall formation (Fig. 12). The two cells thus formed divided simultaneously either by vertical or transverse wall formation (Figs. 13 and 14). The next division in either case was at right angles to the previous plane of division resulting in the formation of two tiers of four cells each (Fig. 15). The upper tier of four cells was transformed into a four celled micropylar haustorium which was aggressive and persisted even in the mature seed (Fig. 16). After further divisions

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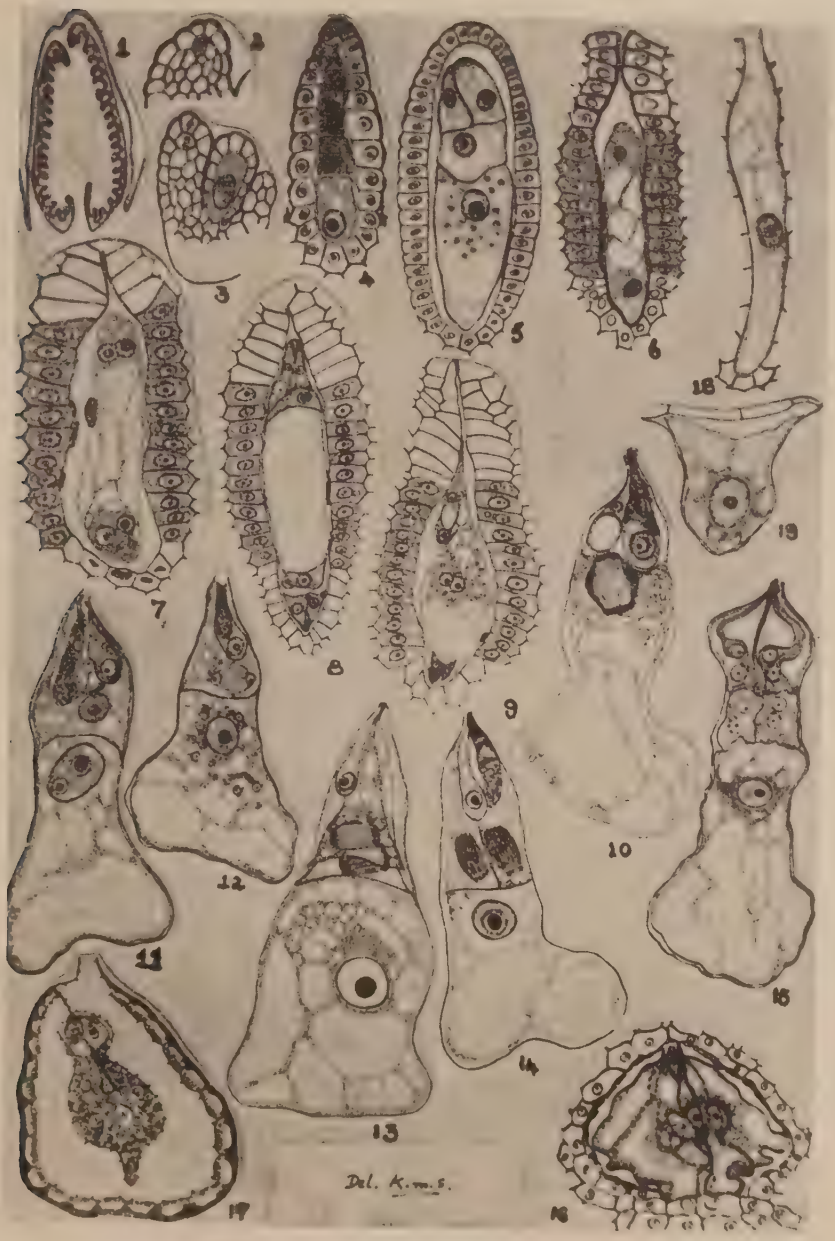
FIGS. 1–19. *Bacopa Hamiltoniana*. 1. Longitudinal section of the ovary, × 50. 2. Primary archesporium, × 400. 3. Megaspore mother cell, × 400. 4. Linear tetrad, upper three degenerating, × 800. 5. T-shaped tetrad, × 900. 6. Two nucleate embryo sac, × 900. 7. Four nucleate embryo sac, × 800. 8. Eight nucleate embryo sac, × 650. 9. Mature embryo sac, × 900. 10. First division of the primary endosperm nucleus, × 800. 11. Formation of the primary micropylar and chalazal chambers, × 800. 12. Vertical division in the micropylar chamber, × 650. 13. Simultaneous longitudinal divisions of the two cells in the micropylar chamber, × 650. 14. Same as above but in the transverse plane, × 800. 15. Four celled micropylar chamber, uninucleate chalazal chamber and the four celled endosperm, × 425. 16. Micropylar haustorium, × 250. 17. Longitudinal section of the mature seed, × 90. 18. Chalazal haustorium at an early stage, × 250. 19. Chalazal haustorium at a late stage, × 250.



Figs. 1–19. *Bacopa Hamiltoniana.*

the remaining four cells of the lower tier gave rise to the endosperm tissue. When the endosperm was fully developed, divisions in the egg started (Fig. 17).

The nucleus of the chalazal chamber did not divide and the cell functioned directly as the chalazal haustorium (Figs. 18 and 19). It was long, tubular and penetrated into the chalazal region thus manifesting an aggressive type of development. Only in a single case the nucleus appeared to have undergone a division forming a binucleate chalazal haustorium. In contrast to this, Srinath (1940) reported the nuclear division in the chalazal chamber as a common feature in *Bacopa Monnieri*. With the exception of a binucleate condition in the chalazal haustorium of *B. Monnieri* the mode of development of endosperm in the species under study was similar.

SUMMARY

A brief account of the female gametophyte and endosperm formation in *Bacopa Hamiltoniana* (Benth.) Wettst., a member of the Scrophulariaceae, is presented. The mode of development of the female gametophyte conforms to the monosporic eight nucleate type.

The development of the endosperm is *ab initio* cellular. The first division of the primary endosperm nucleus is transverse, separating off micropylar and chalazal chambers. The latter directly functions as the chalazal haustorium by penetrating deep into the chalazal tissue of the ovule. In the micropylar chamber the first division is vertical. The following divisions are either vertical or transverse but always result in the formation of two tiers of four cells each. The upper four cells constitute the four celled micropylar haustorium, which remains even in the mature seed. The lower tier of cells of the micropylar chamber by further divisions gives rise to the endosperm tissue.

The mode of development in *B. Hamiltoniana* is compared with that of *B. Monnieri* with respect to the above mentioned features.

ACKNOWLEDGMENTS

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Chemical Composition of Rye Grown on Different Soil Types in Ontario, Canada

VI. Ascorbic Acid Content of the Plants[1]

F. L. Wynd[2] and G. R. Noggle[3]

INTRODUCTION

The problem of the effect of the nutritional environment on the ascorbic acid content of plants is particularly perplexing to plant physiologists. It is common knowledge that the concentrations of this vitamin in plant tissues vary between wide limits, and to date, students of the problem have not been able to observe consistent relationships between these variations and the state of nutrition of the plant. But it seems unlikely on theoretical grounds that any fundamental behavior of plants should be truly independent of its nutritional environment.

The present writers have reported observations on the apparent relationships between several chemical properties of the soils in the vicinity of Midland, Douglas County, Kansas, on the ascorbic acid content of immature oats (2) and rye (3). Correlations between the concentrations of this vitamin and other components in the tissue were also described (1). A later paper (5) pointed out that, in the vicinity of Midland, Kansas, the concentrations of ascrobic acid in immature grass tissue was strongly positively correlated with the growth rate of the plants *if* the fertility level of the soil was sufficiently high. If the level of fertility, expressed in terms of the organic matter, nitrogen, replaceable bases, and chemosorbed phosphorus, was below a certain value, negative correlations between the concentrations of ascorbic acid and growth rate were observed.

It is not known how generally applicable are the relationships, observed at Midland, between soil fertility and the ascorbic acid concentrations in plants. It seems unwise to assume that these results represent a fundamental relationship until comparable data have been obtained from different areas. The authors hope that the extension of the study of the effects of nutrition on the amount of ascorbic acid in crops to include comparable studies carried out under many different conditions may ultimately permit a better understanding of the nutritional factors which influence the formation, or accumulation, of ascorbic acid in forage crops.

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Contribution No. 50–3 of the Department of Botany and Plant Pathology, Michigan State College.

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MATERIALS AND METHODS

The samples of rye used in the present study were from the same material which furnished the data in the previous reports on the nitrogen content (6), nitrogen partition (7), soluble nitrogen (8), mineral components (9), and carotene content (10). The crops were harvested at, or just before, the jointing stage and quickly dehydrated in an Arnold dehydrator. The ascrobic acid was determined in the dried samples by the procedure previously described (2).

The five types of soils were chosen to represent widely different nutritional conditions within a limited area. The analytical data concerning the soils were published in an earlier report (6).

The data are presented in Table 1, and in figures 1 to 16 inclusive. The points in the figures enclosed in solid circles represent data for the first cutting, and those enclosed by broken circles represent data from the second cutting. The numbers of the points refer to the soil types listed in the table, and they coincide with the soil data previously published (6). The graphical units are those which appear in the tables.

TABLE 1. *Ascorbic acid concentrations in the two crops of rye grown on five types of soils.*

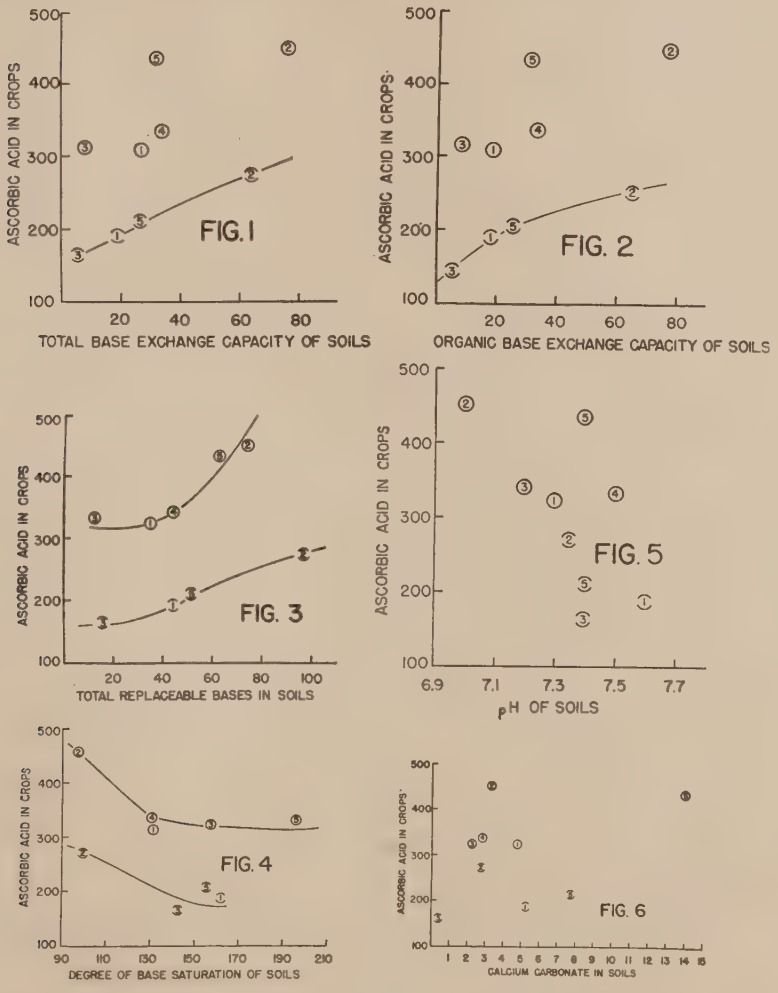
SOIL	ASCORBIC ACID MGR. %	
	1st cutting	2nd cutting
1 Clyde silt loam	307	194
2 Muck	451	274
3 Berrien sand	322	161
4 Thames clay loam	338	....
5 Sandy muck	435	210

EXPERIMENTAL RESULTS

Total base exchange capacity.—The total base exchange capacity is shown by figure 1 to be strongly positively related to the concentration of ascorbic acid in the tissue of immature rye. The data from the second cutting are especially consistent, although a positive relationship is also clearly evident from the first harvest. The concentrations of ascorbic acid are significantly greater in the crops of the first harvest, a condition which indicates that the concentration of ascorbic acid also is sensitive to other factors than the total base exchange capacity.

Organic base exchange capacity.—Figure 2 shows that the concentrations of ascorbic acid in the crops also were clearly related to the organic base exchange capacity of the soil just as in the instance of the total base exchange capacity. An especially strongly positive relationship is observed from the data of the second cutting, although the relationship also is evidently positive for the data of the first cutting. The significant difference in the ascorbic acid concentration in the two cuttings indicate again the influence of other factors.

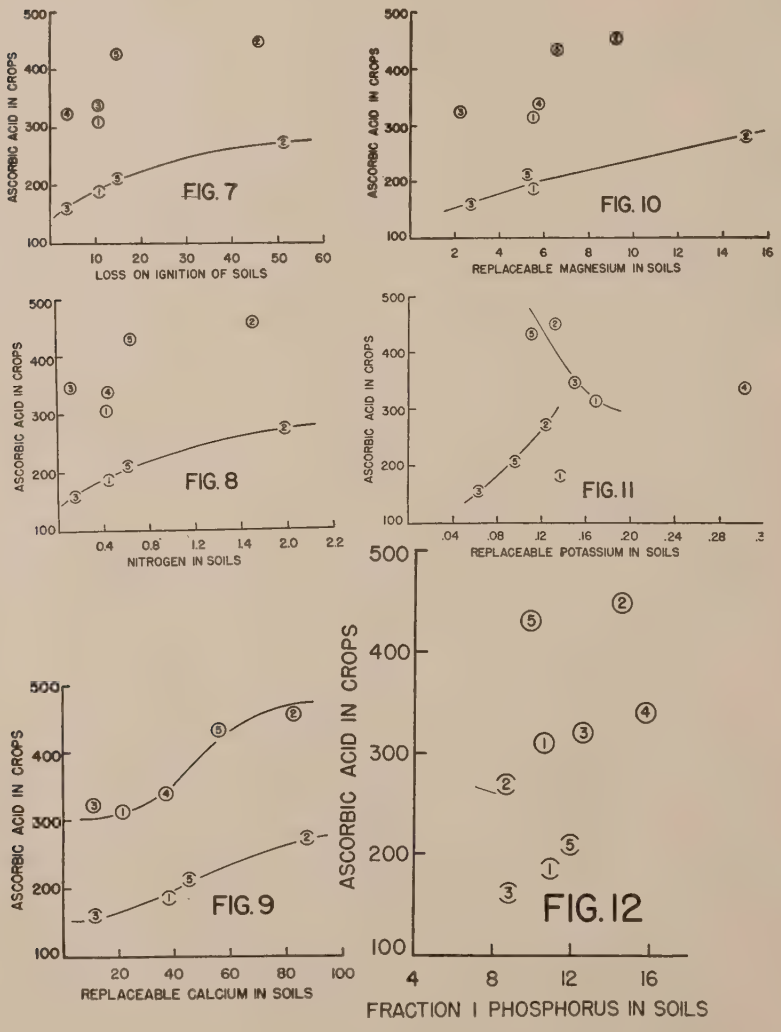
Total replaceabe bases.—The data presented in figure 3 show a consistently positive relationship between the amount of ascorbic acid in the crops and the total replaceable bases in the soils. Just as in the instances described above, the very great difference between the con-



centrations of ascorbic acid in the different cuttings indicate that additional factors influenced the amount of ascorbic acid in the plant.

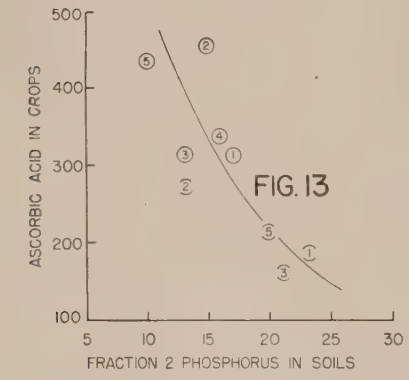
The replaceable bases were determined in an ammonium acetate leachate, and the values are therefore too high for the calcareous soils. Perhaps it would be more strictly correct to define this soil factor merely as the "ammonium acetate" soluble bases, rather than "replaceable bases."

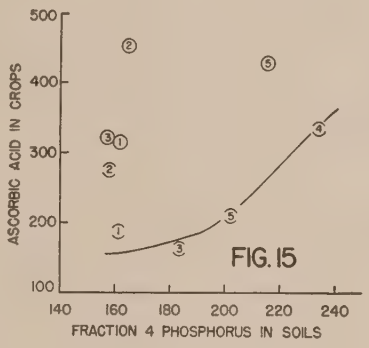
Degree of base saturation.—The degree of base saturation appears to be negatively related to the ascorbic acid concentration in the crops, but the fact that the concentrations of ascorbic acid are significantly different in the two cuttings supports the supposition that other factors

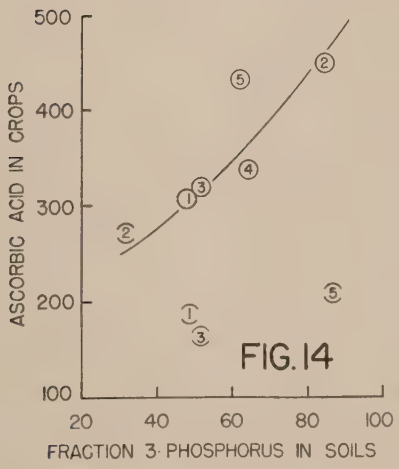


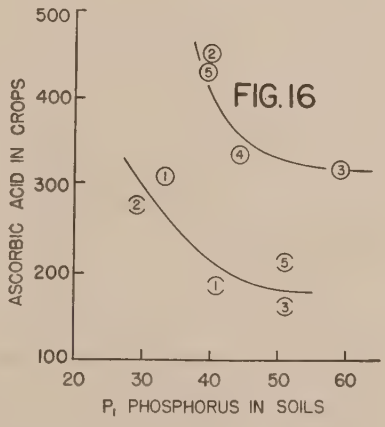
are also influential. It would be difficult to ascribe an intrinsic effect of the degree of base saturation in spite of the distribution of the data in figure 4. For example, the total replaceable bases might be the more significant factor, in which case the distribution of the points in figure 4 would depend on the fact that the soils containing the greater amounts

of replaceable bases happened to be also those least saturated. It should be recalled that the replaceable bases were determined in the ammonium acetate leachate, and that the values are therefore too high for the calcareous soils. However, the data presented represent empirical results, clearly associating the concentration of ascorbic acid in the plants with this soil factor although the interpretation of the causal mechanism is unavoidably vague.









pH.—The data presented in figure 5 are particularly interesting. In the instances of the factors described above, the ascorbic acid contents of the crop of any one cutting were related to the soil factors discussed, although the two cuttings differed markedly in their ascorbic acid content. This situation shows that factors other than the soil factors described also are influencing the concentration of this vitamin in the plants. However, the points in figure 5 form a consistent group in which the lower ascorbic acid concentrations of the second cutting are distributed in such a manner as to suggest that the higher pH values of the soils were associated with the lower ascorbic acid con-

centration of the second cutting. Of course, this situation does not mean necessarily that the pH values themselves are the intrinsically significant governing cause of the lower vitamin concentrations in the crops of the second cutting. It seems more probable that the pH values reflect soil conditions which were the truly significant factors.

Calcium carbonate.—The data presented in figure 6 indicate that no discernible relationship existed between the concentration of ascorbic acid in the crops and the amounts of calcium carbonate in the soils.

Organic matter.—Figure 7 shows that the amounts of organic matter in the soils, as determined by the percentage loss on ignition, were positively related to the ascorbic acid content of the young rye plants. As in several instances described above, the higher ascorbic acid concentrations in the first cutting indicated the influence of additional factors.

Nitrogen.—The amounts of nitrogen in the soils are shown by figure 8 to bear a positive relationship to the concentrations of ascorbic acid in the crops. Yet again, the difference in the general level of ascorbic acid in the different cuttings shows that additional factors also influenced the accumulation of this vitamin.

Replaceable calcium.—The amounts of replaceable calcium in the soils are shown by figure 9 to be clearly positively related to the concentrations of ascorbic acid in the crops, although the differences between the general level of ascorbic acid concentrations in the two cuttings suggest that other factors also influenced the concentration of this vitamin.

Replaceable magnesium.—The distribution of the points in figure 10 are very similar to that in figure 9 and shows a definite positive relationship to exist between the concentration of ascorbic acid in the immature rye and the amounts of replaceable magnesium in the soil. Factors other than this soil factor were again influential since the concentrations of ascorbic acid were much greater in the crops of the first harvest.

Replaceable potassium.—Figure 11 shows that no consistent relationship existed between the ascorbic acid concentrations in the rye plants and the amounts of replaceable potassium in the soils. In the material of the first harvest, the relationship appears to be negative, while the material of the second harvest indicates a positive relationship. It is evident that factors other than the amount of replaceable potassium are governing the accumulation of ascorbic acid in the plants.

Fraction 1 phosphorus.—The soil phosphorus indicated as "fraction 1" was determined by rapid leaching with 0.1 N neutral ammonium fluoride. Figure 12 shows that this phosphorus fraction was not related to the ascorbic acid content of the plants.

Fraction 2 phosphorus.—The fraction 2 phosphorus was determined by rapid leaching with 0.1 N ammonium fluoride in 0.01 N hydrochloric acid. Figure 13 indicates that a consistently negative relationship existed between the ascorbic acid content of the crop and the amount of phosphorus in the soil in this fraction. Figure 13 should be compared with figure 5 which relates the pH values of the soils to the ascorbic acid content of the crops. It is especially noteworthy that this fraction 2 phosphorus is one of the few soil factors determined that is consistently

related to the ascorbic acid content of the entire group of samples, even though the concentrations of this vitamin are significantly lower in the crops of the second cutting. The authors are unable to suggest an explanation of this unusual relationship.

Fraction 3 phosphorus.—This phosphorus fraction was determined by shaking the soil sample with neutral 1 N ammonium fluoride for one hour. The distribution of the data presented in figure 14 shows that a positive relationship existed between the concentration of ascorbic acid in the plants and the amount of soil phosphorus in this fraction. This situation did not exist, however, for the data of the second cutting.

Fraction 4 phosphorus.—The fraction 4 phosphorus was extracted by shaking the soil sample with 0.002 N sulphuric acid at pH = 3.0 and then adding dry ammonium fluoride and shaking for an additional hour. The distribution of the data presented in figure 15 is somewhat irregular, but the general trends of the relationships are positive for the data of both the first and second cuttings.

P_1 phosphorus.—This fraction of the soil phosphorus was extracted by shaking the sample of soil for one hour with neutral 1 N ammonium fluoride. The data presented in figure 16 indicate that a negative relationship existed between the amount of ascorbic acid in the crops and the amount of P_1 phosphorus in the soil, although it is also evident from the difference in the ascorbic acid content in the crops of the different cuttings that additional factors were also effective.

SUMMARY AND CONCLUSIONS

1. The concentration of ascorbic acid in two cuttings of immature rye, grown on five markedly different types of soils were determined, and these concentrations were compared to several chemical characteristics of the soils.

2. Positive relationships were observed between the amount of ascorbic acid in the plants and the total base exchange capacity, organic base exchange capacity, total replaceable bases, organic matter, nitrogen, replaceable calcium, replaceable magnesium, fraction 3 phosphorus, and fraction 4 phosphorus. These positive relationships were true only when the data for each cutting were grouped separately. The conspicuously greater level of ascorbic acid concentrations in the crops of the first cutting indicate that factors other than those listed were also related to the ascorbic acid concentration.

3. Negative relationships were observed between the ascorbic acid concentration in the plants and the degree of base saturation of the soils, and the P_1 fraction of soil phosphorus, but these negative relationships were evident only if the data for the two cuttings were grouped separately. This situation again indicates that factors other than those listed were related to the concentration of ascorbic acid in the plants.

4. Negative relationships were also observed between the amount of ascorbic acid in the crops and the pH value of the soils and the fraction 2 phosphorus in the soils. In these instances, however, all the data from both cuttings could be pooled without disturbing the consistently negative nature of the relationships.

5. It is suggested that the soil factors described intrinsically govern the concentration of ascorbic acid in the crops, either when they are grown simultaneously or when they are grown successively, for the possibility exists that the magnitudes of soil factors studied were themselves dependent on undetermined but critically important factors.

6. No consistent relationships were observed between the ascorbic acid concentration in the crops and the amount of calcium carbonate in the soils, the replaceable potassium or the fraction 1 soil phosphorus.

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Chemical Composition of Rye Grown on Different Soil Types in Ontario, Canada

VII. Relationships Between Concentrations of Ascorbic Acid and Other Components in the Plant[1]

F. L. Wynd[2] and G. R. Noggle[3]

INTRODUCTION

There is great uncertainty at the present time concerning the factors which govern the wide variation of ascorbic acid content in plants. Many reports of the effect of fertilizers on the accumulation of this vitamin have been published, but the results have been so conflicting that many students have concluded that the concentrations of ascorbic acid in plants bear no consistent relationship to the nutritional environment. It seems illogical to assume that the state of nutrition of plants would be unrelated to the formation and accumulation of such an important and omnipresent cellular constituent as ascorbic acid. Especially does such an assumption appear to be erroneous when it is recalled that astonishingly wide variations of the concentration of ascorbic acid do occur and certainly must be due to some physiological cause .

All workers in the field of plant nutrition know that often the amount of a nutrient in soils does not necessarily parallel the amount of the nutrient actually present in the plants. It follows, therefore, that relationships might be found between the amounts of ascorbic acid and certain components of the tissue even if such relationships were not found between this vitamin and fertilizer treatments.

The purpose of the present paper is to describe the relationships between the concentration of ascorbic acid in immature rye plants and certain components of the tissue which are known to be more or less dependent on fertilizer treatment. It does not follow that the relationships described below represent cause and effect factors, but it does follow that this type of study, if extended to include many conditions of growth, might ultimately lead to an acceptable interpretation of the effect of the nutritional state of the plant on its ascorbic acid content.

MATERIALS AND METHODS

Rye was grown on five strikingly different types of soils in the vicinity of Wallaceburg, Ontario. Two successive crops were harvested just before, or at, the jointing stage. The material was quickly dried

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in an Arnold hot air dehydrater and the samples were mailed to the laboratory for analysis. The samples were identical with those which furnished the previously published data on the nitrogen content (2), distribution of nitrogen fractions (3), partition of soluble nitrogen (4), mineral components (5), carotene content (6), and ascorbic acid content (7). The analytical data pertaining to the soils were presented in the first paper of this series (2). The data pertinent to the present discussion are reassembled in Table 1, and they are graphically presented in figures 1 to 6 inclusive. The points in the figures enclosed by solid circles represent data from the first harvest, and those enclosed by broken circles represent data from the second harvest. The numbers of the points refer to the types of the soils which furnished the data

TABLE 1. *Ascorbic acid and other components in the first cutting of rye expressed on the dry weight basis, and grown on five types of soils.*

Soil	Ascorbic acid mg. %	Nitrogen %	Calcium %	Magnesium %	Potassium %	Iron mg. %	Phosphorus %
1 Clyde silt loam.....	307	2.15	0.421	0.368	2.63	71	0.328
2 Muck.....	451	4.41	1.170	0.644	2.62	108	0.309
3 Berrien sand	322	2.11	0.502	0.288	1.66	47	0.328
4 Thames clay loam.....	338	2.09	0.446	0.480	2.90	85	0.263
5 Sandy muck.	435	3.57	1.170	0.725	2.58	98	0.339

TABLE 2. *Ascorbic acid and other components in the second cutting of rye expressed on the dry weight basis, and grown on five types of soils.*

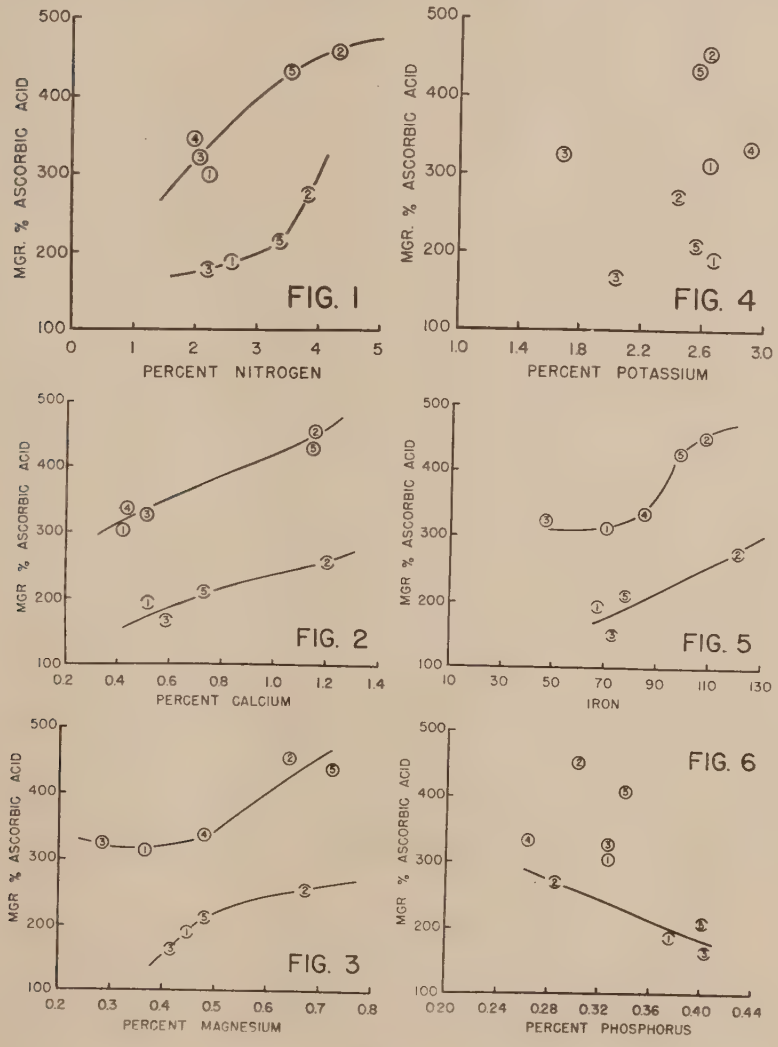
Soil	Ascorbic acid mg. %	Nitrogen %	Calcium %	Magnesium %	Potassium %	Iron mg. %	Phosphorus %
1 Clyde silt loam.....	194	2.54	0.519	0.442	2.65	68	0.379
2 Muck.....	274	3.83	1.210	0.675	2.44	122	0.285
3 Berrien sand	161	2.20	0.586	0.422	2.03	73	0.405
4 Thames clay loam.....	...	....	.....	.....	....	..	.....
5 Sandy muck.	210	3.41	0.718	0.480	2.56	78	0.401

and they agree with those in the table. The units used in the graphs are identical to those indicated in the table. The analytical methods used are cited in the previous papers (5, 6). The curves drawn in the figures were sketched freehand and represent only trends, and are not intended to indicate mathematically determined relationships.

EXPERIMENTAL RESULTS

Nitrogen.—The data presented in figure 1 indicate that the concentrations of ascorbic acid in the young rye plants were positively

related to the nitrogen content of the tissue, although it is interesting to note that some undefined effect of season or the physiological state of the plants caused a lower ascorbic acid concentration in the material of the second cutting. It was formerly reported by the authors (1) that the ascorbic acid concentration in immature oats and rye grown



in the vicinity of Midland, Douglas County, Kansas, was related positively to the nitrogen content of the soil, and to the growth rate of the plants, if the general fertility level of the soil was above a certain value. It is not known how generally this situation is true, nor how this critical value of the fertility level might vary under different

conditions and in different areas, but it should be noted that the fertility levels of the soils included in the present study were well above the critical value determined for the Midland area.

Calcium.—Figure 2 shows that a markedly positive relationship existed between the ascorbic acid content of the plants and the percentage of calcium in the tissue. Just as in the instance of nitrogen, this positive relationship existed for the data from each cutting, but not for the pooled data of both cuttings, and again it is evident that factors other than the calcium content are related to the ascorbic acid content.

Magnesium.—The curves in figure 3 indicate a positive relationship between the concentration of ascorbic acid and the percentage of magnesium in the tissue, although a marked difference in the general level of the ascorbic acid concentration in the different cuttings is evident.

Potassium.—The distribution of the points in figure 4 discloses no discernible trend in the relationships between the concentration of ascorbic acid and the amount of replaceable potassium in the soil.

Iron.—The data presented in figure 5 are especially interesting. It has been suggested several times in the published literature that the formation of ascorbic acid in plant tissues is dependent on some oxidation mechanism involving iron or manganese, and the data in figure 5 appear to support this view. The present authors, however, believe that the accumulation of ascorbic acid in plant tissue probably is not intrinsically positively correlated with the concentration of iron, but rather with a subtle secondary relationship between iron and copper. Detailed studies are now in progress concerning the relationship between oxidation mechanism in the plant tissue and ascorbic acid formation, and a report of these studies will be presented in the near future.

Phosphorus.—The data presented in figure 6 are inconclusive. The points for the first harvest show no trend, but those for the second indicate a negative relationship between the concentration of ascorbic acid and phosphorus. It is interesting to note that phosphorus is the only component of the tissue studied which exhibits variations in concentration which seem to be related not only to the variation of ascorbic acid (in the second cutting) but also to the general diminution of the amount of this vitamin in the second cutting. The data, however, are too few to permit a convincing generalization to be made.

SUMMARY AND CONCLUSIONS

1. Rye was grown on 5 markedly different types of soils and twice harvested at, or just before, the jointing stage. The concentrations of ascorbic acid, nitrogen, calcium, magnesium, potassium, iron, and phosphorus were determined.

2. The concentrations of ascorbic acid were positively related to the percentage of nitrogen, calcium, magnesium, and iron.

3. There was no consistent relationship between the ascorbic acid content and the percentage of potassium.

4. The data concerning phosphorus were inconclusive, but a gen-

erally negative relationship was observed between the concentrations of phosphorus and ascorbic acid.

5. The ascorbic acid contents of the crops of the second cutting were markedly lower than those of the first. This diminution of the ascorbic acid content in the second cutting was not related to any corresponding change in the concentration of the tissue components studied, with the possible exception of phosphorus.

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A Needle Blight of Pine

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In November, 1948, a bundle of white pine seedlings, ranging in size from twelve to eighteen inches in height, was received by the writer from the forest nursery located near Marietta, Ohio. These seedlings showed considerable browning and killing of needles.

Specimens of this disease had been examined by a number of pathologists, who had suggested that the trouble might be due to *Diplodia* or *Lophodermium*. However, no species of either of these genera was experimentally established as the pathogen.

Fig. 1. The plant on the right shows more marked symptoms. Most of its leaves are severely diseased. Inoculation was made by dipping leaves in a spore suspension. (Photograph by Lyle Udall.)

Symptoms of this disease are as follows: needles show yellowish areas at the tips, such areas turning brown completely or in lines or striations. These discolorations travel down the needle to its base (Fig. 1), the needle later being cast from its fascicle. At Marietta entire bedrows of white pines were defoliated, the seedlings overwintering in this condition and producing a new crop of apparently healthy needles in the spring.

Isolations made in the plant pathology laboratory of the Department of Botany of the Ohio University from the white pine seedlings from Marietta and from similarly infected needles from white pine trees near Athens, Ohio, have yielded cultures of *Pestalozzia*, probably the species *funerea* (Fig. 2). Several such isolations have been made.

FIG. 2. Multicellular spores of Pestalozzia. Note the clearer end cells and setae borne at the ends of the spore. (Photograph by Lyle Udall.)

Inoculations of white pine seedlings in the greenhouse with this fungus have given positive infections from which the pathogen has been successfully reisolated. Consequently, the suggestion is made that this disease might be considered as white pine needle blight caused by a species of *Pestalozzia*, probably *P. funerea.*

The writer is continuing work on this disease in an attempt to determine the various phases of its etiology, host range and control measures.

New Proteaceae from Colombia

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Certain species of Protaeceae are large trees which, in some regions of Colombia, constitute an important element in the Andean forest of medium altitude and temperate climate. Species of *Euplassa* and *Panopsis* produce timber of good quality and are known in the country by the common name "Yolombo." In the Valle del Cauca species of *Roupala* are called "Carne de fiambre," the most common of which is *R. obovata* HBK, a polymorphic species I collected in several places. In this article five new species of this family collected in the Department of Valle del Cauca are described as new and a new combination is proposed by Mr. E. P. Killip for a species from Antioquia described long ago by Dr. Posada Arango.

Euplassa Duquei Killip et Cuatr., sp. nov.

Arbor magna, plerumque 30 met. alta, caule 80 cm. diam. cortice griseo-brunneo sectione pallido-brunneo, ligno pallido-brunneo extus ochraceo-albicanti. Ramuli viridi-brunnei copiose lenticellati puberuli, extremis viridi-ochraceo-tomentellis.

Folia alterna paripinnata 3-juga vel 2-juga. Rhachis valde robusta, petiolum inclusum 10–30 cm. longa, lenticellata puberula, petiolo basi incrassato 5–12 cm. longo, internodiis periolum subaequilongis. Foliola opposita petiolulata rigide coriacea, petiolulo 5–10 mm. longo robusto basi magis incrassato, lamina ovata vel obovata vel ovato-rotundata, asymmetrica, apice rotundata basi cuneata vel subtruncata, margine leviter repando sinuata, 10–22 cm. longa, 7–14 cm. lata, pari superiore breviore (in foliis trijugis) medio maximo; supra viridis nervis principalibus bene conspicuis tomentellis, venulis elevatis in minuto reticulo anastomosatis, minutis pilis curvatis sparsis in statu juvenile copiosioribus munita; subtus pallide viridis vel ochraceo-viridis, in sicco viridi-ferruginea, tomentulosa, pilis brevibus simplicibus vel furcatis crispis copiosis munita, costa crassa valde eminenti pallida, nervis secundariis prominentibus pallidis 5 utroque latere brachiato-ascendentibus saepe a parte media vel extremo furcatis marginem versus irregulariter anastomosatis, nervis tertiariis prominentibus vel prominulus laxe irregulariterque reticulatis, venulis numerosis conspicuis minute reticulatis.

Inflorescentiae axillari-terminales pseudoracemosae. Axis valde robustus 10–25 cm. longus (vulgo 15–18 cm.) ochraceo- vel viridi-ochraceo-tomentosus, in sicco ferruginescens. Bracteae lanceolatae 1–1.5 mm. longae. Pedicelli crassiusculi rigidi cum bracteis alabastrisque dense tomentosi 5–6 mm. longi, apice plusminusve bifurcati biflori. Alabastra 10–11 mm. longa tubulosa zygomorpha, apice cernuo oblique capitato, per paria disposita. Sepala 4 linearia apice subcucullata, circa 14 mm. longa, 1.5–2 mm. lata, in anthesi superiore

erectum reliqua extrorsum arcuata postremo contorta textus dense ochraceo-tomentosa, intus filamento staminale connexa alba corrugata. Antherae subsessiles connectivo crasso elliptico apice obtusiusculo, saccis introrsis. Discus crassus tetragonus breviter tetralobatus. Pistilum viride 11–12 cm. longum glabrum ovarium uniloculare 2 ovula subpyriformia apice affixa, stigmate crasse obliqueque capitato-clevato.

TYPE: Colombia, Dep. Valle. Cordillera Occidental, Hoya del río Cali: río Pichindé, cerca de El Olivo 2075 m. alt., colect. 6-VIII-1946 J. Cuatrecasas 21976. "Arbol 30 m. alt. Tallo 80 cm. diam. Corteza grisácea pardusca, sección pardo clara. Madera pardo-clara, ext. ocráceo blanquecina. Hoja coriácea, rígida, verde brillante haz, verde mate claro envés, nervio principal y laterales amarillento claros. Ramas inflorescencia y pedúnculos ocráceos u ocráceo verdosos. Tépalos exteriormente ocráceos, por dentro blancos. Pistilo verde. "Yolombo blanco." (F., isotype US.)

Other collection: Colombia, id. id. río Pichindé, entre Los Carpatos y El Olivo, 1920—2025 m. alt., colect 5-VIII-1946 J. Cuatrecasas 21947. "Arbol grande. Corteza grisáceo pardusca, sección pardo clara, 1 cm. gruesa. Madera pardo clara, ext. blanco ocrácea. Hoja coriácea, delgada, rígida, verde amarillenta oscura haz, verde clara o verde ocrácea envés. Inflorescencias y capullos ocráceo ferruginosos." "Yolombo blanco."

Other collection: Colombia, id. id. Hoya del río Cali: El Recuredo, 2000 m. alt. colect. J. M. Duque Jaramillo 1599 (USNH), Duque Jaramillo 282 (F.) "Yolombo blanco."

In my opinion Duque's two numbers belong to the same collection. The specimen at the USNH has a fruit which most likely belongs to another species. This fruit, certainly collected at a different time and probably at another locality, is very similar to *P. rubra*.

As a species *E. Duquei* is very well characterized by its large broad leaflets which are tomentulose on the lower side and less so on the upper surface, and prominently veined. The peduncles are thick and bifid at the end. The flowers are of medium size and the ovary is glabrous.

Panopsis rubra Killip et Cuatr., sp. nov.

Arbor 25 met. alta. Caulis 30 cm. diam., cortice brunnescenti plusminusve fissurato sectione 8 mm. lato roseo, ligno carneo-rubro. Ramuli fusci subnitidi glabri, hornotini fulvo-tomentulosi.

Folia simplicia petiolata alterna rigide coriacea. Petiolus 2–4 cm. longus rigidus supra sulcatus reliquus rotundatus et striolatus, in junioribus puberulus mox glaber. Lamina elliptica vel elliptico-oblonga utrinque attenuata apice obtusiuscula basi saepe asymmetrica obtusa vel subrotundata, margine integra, 7–16 cm. longa, 4–7.5 cm. lata; supra plumbeo-viridis, nervo medio impresso lateralibus conspicuis nervulis venisque prominulis reticulatis, in juvenilibus puberula denique glabrata; subtus luteolo-viridis costa valde eminenti, nervis lateralibus prominentibus patulis arcuato-ascendentibus inter eos et cum tertiis paucis laxe anastomosatis, venulis minute arguteque reticulatis subglabris etiam minutis sparsissimis pilis munita.

Inflorescentiae paniculatae terminales 8–12 pseudoracemis multifloris brachiatis congestis vel laxis, brevissime pedunculatae. Axis 4–6 cm.

longus robustus dense fulvo-tomentosus in racemum terminalem 8–14 cm. longum productum. Ramuli brachiati dense fulvo-tomentosi in sicco pallido-ferruginei 5–14 cm. longi. Bracteae lineares minutissimae tomentosae valde deciduae. Pedicelli teneres graciles patentes 3–4 mm. longi hispido-tomentelli, solitarii vel 2–3 approximati. Alabastra anguste tubulosa apice subcapitata 5–6 mm. longa 1 mm. crassa dense tomentosa. Sepala 4 libera anguste linearia circa 6 mm. longa anthesis 0.6 mm. lata extrorsum spiraliter revoluta extus tomentosa intus glabra. Stamina 4 sepala aequilonga filamentis luteolo-albis anguste linearibus complanatis corrugatis tantum breviter basi sepala coalita, reliquis liberis; antheris oblongis 1–1.2 mm. longis, connectivo lineare crassiusculo, saccis oblongis introrsis. Pistylum 5 mm. longum stylo tenui capillari villoso apicem versus glabrato subapice nunc vel vix incrassato, stigmate punctiforme glabrum, ovario dentissime hispido-tomentoso uniloculare 2 ovulis pendulis. Discus membranaceus tubuloso-cupuliformis 4-dentatus, dentibus lanceolatis.

Fructus globulosus apice rotundatus sed brevissime obtusissimeque apiculatus 4.5–6 cm. diam., pericarpio lignoso 7–9 mm. crasso indehiscenti; semina unica, transverse oblonga 22 x 30 mm. cotyledonibus subhemisphaericus valde feculentis. Ramusculi fructiferi robusti 4–5 mm. crassi. Pedicelli fructiferi valde crassi brevissimi 4 mm. long.

TYPE: Colombia, Dep. del Valle; Cordillera Occidental, Hoya del río Cali, vert. izquierda del río Pichindé, arriba de Tareas, 2400 m. alt., 25-VII-1946 colect. J. Cuatrecassas 21725. "Arbol 25 m. Hoja coriácea, rígida, verde plomizo claro o verde amarillenta. Ramillas inflorescencia rubio tomentosus. Perianto ext. id., int. blanco amarillento." "Yolombo colorado." (F., isotype US.)

COTYPE: Colombia en id. id.: río Pichindé entre Los Cárpatos y El Olivo, 1920—2025 m. alt., 26-VII-1946 colect. J. Cuatrecasas 21741. "Arbol 25 m. Tallo 35 cm. diam. Corteza pardusca agrietada, seccion 8 mm., rosada. Hoja coriácea, rígida, verde plomiza clara haz, verdoso amarillento clara envés. Lleva frutos." "Yolombo colorado."

P. rubra is distinguished by its elliptic, coriaceous, reticulately veined leaves, of glabrous appearance but sparsely hairy, many-flowered inflorescences, slender hirsute pedicels, hirsute ovary, filiform long style and conical disc with 5 long lanceolate-triangular teeth. It is closely related to *P. polystachya* Ktz., but its styles are much more slender, capillary, villose, and somewhat longer; the flower is also longer and more slender than in *P. polystachya*.

Panopsis Metcalfii Killip et Cuatr., sp. nov.

Arbor 20 m. alta. Rami teretes brunneo-grisei ruguloso-lenticellati, juveniles tomentosi.

Folia simplicia alterna petiolata firme coriacea. Petiolus robustus 10–35 mm. longus supra plano-sulcatus subtus teres glaber vel glabrescens. Lamina obovato-elliptica apice rotundata vel subrotundata, basim versus attenuata, cuneata, 8.5–17.5 cm. longa, 3.5–6.5 cm. lata margine integra; supra costa nervis lateralibus conspicuis, nervulis venisque paulo elevato-reticulatis in junioribus puberula denique sparsissimis pilis; subtus sparsis minutis pilis munita, costa crassa elevata, nervis secundariis prominentibus 3–4 utroque latere

FIG. 1. A, leaflet of *Euplassa Duquei* (× ⅔). B and C, pedicel with its pair of flower buds (× 1⅓). D, pair of open flowers on its pedicel (× 1⅓). E, front view of a staminate sepal (× 2⅔). F, lateral view of staminate sepal. G, pistil (× 2⅔). H, fruit of *Panopsis mucronata* (× ⅔).

tortuosi ascendentibus angulo valde acuto cum nervis tertiariis minus prominentibus laxe reticulato-anastomosatis, nervulis venisque minute elevato reticulatis.

Inflorescentiae terminales paniculatae multiflorae 10–12 ramulis patulis. Racemi ad 22 cm. longi, axe dense adpresseque tomentoso. Pedicelli 6–8 mm. longi mediocri crassiusculi patuli tomentulosi. Discus membranaceus cupuliformis 4-dentatus. Ovarium ovoideum apice angustatum valde hirsutum. Stylus filiformis basim versus villosus apice non vel vix incrassatus. Stigma punctiforme.

TYPE: Colombia, Dep. Antioquia: Between Yarumal and Llanos de Cuiba, 2300–2700 m. alt., collect. Febr. 20, 1942, R. D. Metcalf & J. Cuatrecasas 30148. "Tree 20 m. high." (US.)

P. Metcalfii is closely related to *P. rubra*, but has obovate-elliptic leaves, rounded at the apex and attenuate at the base, less prominently reticulate with the secondary nerves ascending at a more acute angle, densely tomentose young branches and inflorescences, whereas *P. rubra* is tomentose hirsute. In addition, *P. Metcalfii* has longer and stronger pedicels, and the flowers and inflorescences are usually larger.

Panopsis mucronata Cuatr., sp. nov.

Arbor magna, 40 met. alta. Caulis 70 cm. diam., cortice ruguloso fuscescenti. Ramuli vetusti griseo-brunnei granuloso-lenticellati glabri. Lignum rubescente.

Folia simplicia alterna petiolata rigide coriacea. Petiolus brevis robustus basi incrassatus supra planus circa 5–8 mm. longus. Lamina asymmetrice ovato-oblonga vel elliptico-oblonga basi obtuse vel abrupte cuneata apice plus minusve angustata acutiuscula vel obtusiuscula, margine integra, 13–22 cm. longa, 5.5–9 cm. lata; supra in sicco pallide luteo-viridis, nervis principalibus notatis pallidioribus nervulis laxe reticulatis elevatis, adulta conspectu glabra sed aliquando sparsissimis minutis pilis munita; subtus griseo-viridula nervis principalibus albicantibus, costa valde crassa eminenti, nervis secundariis subpatulis angustis prominentibus plus minusve tortuosis et cum tertiis paucis venulisque elevatis laxe reticulatis, conspectu glabra sed minutissimis pilis sparsis munita.

Fructus rotundus 5–6 cm. diam., apice abruptissime mucronatus, mucrone 6–7 mm. longis conico acutiusculo, pericarpio viridi-brunneo glabro leviter ruguloso lignoso 2.5 mm. crasso, semina solitaria. Pedicellus fructiferus brevissimus crassus, 2 mm. long.

TYPE: Colombia, Departmento del Valle, Cordillera Occidental; Hoya del río Sanquininí, lado izquierdo: La Laguna, bosques 1250–1400 m. alt., 20-XII-1943 colect. J. Cuatrecasas 15676. "Gran árbol, 40 m. alt. Tallo 70 cm. diam. Corteza 15–20 mm. gruesa, pardo rojiza con gomo-resina roja, rugulosa, Madera rojiza, albura hasta 5 cm. espesor blanquecina. Frutos con pericarpo coriáceo, 6 cm. diam., fuertemente apiculados; aun verdes ahora, empiezan a pardear," "yolombo." (F., isotype US.)

P. mucronata, despite lack of flowers and inflorescences, is definitely characterized by its fruit and leaves. The fruits are globose, abruptly apiculate and bear a conical tip of approximately 6 mm. length, the ligneous pericarp being only 2.5 mm. thick (in contrast to other species

such as *Panopsis Volombo* and *P. rubra* which possess a much thicker pericarp). The leaves borne on short petioles are large, have prominent nerves and are loosely reticulate. *P. mucronata* is closely related to *P. suaveolens* Klotsch & Karsten, but differs by its larger and acute leaves, the strongly mucronate fruits and thinner pericarp. According to the description, the leaves of *P. suaveolens* grow in whorls of four.

Roupala pachypoda Cuatr., sp. nov.

Arbor grandis. Caulis 30 cm. diam., cortice fusco-ruguso sectione carneo, ligno duro rubescenti. Ramuli fuscescentes rugulosi lenticellato-punctati, juveniles viridigrisei.

Folia alterna simplicia petiolata crasse rigideque coriacea saepe complicata. Petiolus subteres robustus 14–45 cm. longus in junioribus pubescens denique glaber. Lamina ovata vel sub-obovata basi rotundata vel obtusa juvenilis saepe asymmetrica apice abrupte angustata acutiuscula, margine grosse dentato-serrata et revoluta vel integra, 17–18 cm. longa, 4–12.5 cm. lata; supra plumbeo-viridis siccitate pallida, glabra nervo medio lateralibusque conspicuis reliquis obsoletis; subtus pallidior costa crassa valde elevata, nervis secundariis 8–10 utroque latere prominentibus ascendentibus plus minusve furcato-anastomosatis, nervulis transversis paucis paulo elevatis laxissime anastomosatis; valde juniores puberula mox glabra.

Inflorescentiae axillares longe racemosae foliis duplo longiores, rhachi robusta crassa rigida 12–20 cm. longa, fusca angulata puberula. Bracteolae 1 mm. longae lanceolatae pubescentes deciduae. Pedicelli 1.5–3 mm. longi crassi glabri, solitarii vel geminati sed liberi. Alabastra albicanti-lutescentia vel viridescentia glabra crasse clavato-oblonga, 9–10 mm. longa 3–4 mm. crassa. Sepala linearia 10–12 mm. longa 2 mm. lata glabra. Filamenta cum sepala coalita alba corrugata 5–7 mm. longa. Antherae late lineares 4 mm. longae. Ovarium ovatum 2 mm. longum dense tomentosum uniloculare 2 ovulis complantis pendulis. Styles cylindricus crassus glaber 6–8 mm. longus. Stigma punctiforme. Margo receptaculi 4 glandulis dentiformibus crassis remotis, 0.4 mm. longis.

Rhachis fructifera valde crassa robusta, pedicellis fructiferis crassissimis 3–5 mm. longis 4–5 mm. crassis. Folliculi elliptici subcomplanati apice abrupte acuteque hamato-apiculati, pericarpo valde crasso suberoso, 25–30 mm. longa, 15–17 mm. lato. Semina ovato-elliptica 16–18 mm. longa circa 10 mm. lata.

TYPE: Colombia, Dep. de Caldas. Cordillera Central: Hoya del río Otún Peña Bonita, 2660 m. alt., colect. 27-XI-1946 J. Cuatrecasas 23349. "Arbor. Hoja coriácea, rígida, verde plomiza. Perianto blanco amarillento o verdoso." (F.)

COTYPE: Colombia, Dep. del Valle. Cordillera Central: Hoya del río Bugalagrande: Cuchilla de Barragán, entre Las Azules y Las Violetas, 311 m. alt., colect. 15-IV-1946 J. Cuatrecasas 20799. "Arbol grande. Tallo 30 cm. diam. Corteza pardo rojiza, rugosa, sección cárnea. Madera dura, rojiza." (F.)

Oeher specimen: Colombia, Cauca: Páramo de Puracé, 4000 m. alt. "Tree 4–5 m. high, fls. red and yellow, "fosforos," collect. Sept. 1936, E. Dryander 1777 (US).

R. pachypoda is related to *R. complicata* KBK but differs by its thicker and firmer leaves, abruptly attenuate at the apex, its more robust inflorescences, thicker flowers, shorter and thicker pedicels which become much thicker during fruiting, and by its larger and thickly suberous follicles.

Panopsis Yolombo (Posada) Killip., nov. comb.

Andripetalum Yolombo Posada, Bull. Soc. Bot. France **18**: 374, 1871.

I have seen the following collections:

Col. J. E. Fajardo G. 42: Antioquia, bajo la cumbre cerca de Sta. Elena, 2400 m. alt., colect. 29-X-1946. (F.)

Col. Felix Molina 8: Antioquia, Sierra de la Carretera a Guarne, alt. 2500 m., colect. VIII-1945. (F.)

Col. Nicanor Angel: Caldas, Pacora, 1450 m. alt. (temp. 18°), collect. 1-IX-1943, "yolombo." Specimen with one leaf, flowers and one fruit. (F.)

Photo of type (in Herb. Mus. Paris) collected by Triana, prope Medellin: Macbride 34989 in Herb. of Chicago Nat. Hist. Museum.

Panopsis Yolombo is very cell characterized by its long petiolate, firm, coriaceous leaves, which are obovate, obtusely attenuate at the base, somewhat puberulous on the upper side, densely tomentose pedicels, relatively short flowers, tomentose-hirsute ovary, and glabrous style. The fruit is large (about 6.5 cm. diam.) and hard, surrounded by a thick pericarp (4–7 mm.), containing one large seed full of starch.

Verbenaceous Novelties, Mostly from Madagascar, and Miscellaneous Taxonomic Notes

HAROLD N. MOLDENKE
(*N. Y. Botanical Garden, Bronx Park, New York*)

Callicarpa baviensis Moldenke, sp. nov.

Frutex; ramulis gracilibus obtuse tetragonis dense sordido-puberulis; petiolis gracilibus dense flavido-puberulis; laminis membranaceis elliptico-ovatis vel ovatis ad apicem breviter acuminatis integris ad basim acutis usque ad oblique truncatis utrinque minute puberulis; inflorescentiis axillaribus cymosis paucifloris; pedunculis pedicellisque filiformibus dense puberulis; calyce campanulato plusminusve puberulo et resinoso-punctato subtruncato minute 4-apiculato.

Shrub; branchlets and twigs slender, obtusely tetragonal, densely sordid-puberulent; nodes often annulate; principal internodes 1–3 cm. long; leaves decussate-opposite; petioles slender, 1–3.5 cm. long, densely puberulent with sordid-yellowish hairs; blades membranous, dark-green and brunnescent above, lighter beneath, elliptic-ovate or ovate, 4–8.5 cm. long, 2.3–4.3 cm. wide, short-acuminate at the apex, entire, varying from acute to obliquely truncate at the base, minutely puberulous on both surfaces, especially along the larger venation, glabrescent on the lamina between the larger venation above; midrib slender, plane or slightly prominulous and densely puberulent above, prominulous and densely puberulous beneath; secondaries filiform, 4 or 5 per side, arcuate-ascending, mostly plane above and slightly prominulous beneath; veinlet reticulation rather abundant, sometimes rather conspicuous but plane above and beneath or the many subparallel tertiaries subprominulous; inflorescence axillary, cymose, usually shorter than the subtending petioles, rather few-flowered; peduncles filiform, to 6 mm long or obsolete, densely puberulent; pedicels filiform, 1–2 mm. long, densely puberulent; bractlets setaceous, about 1 mm. long, densely puberulent; calyx campanulate, about 1 mm. long and wide, more or less puberulent and resinous-punctate, its rim subtruncate, minutely 4-apiculate; corolla infundibular, white, its tube cylindric, 5–6 mm. long, densely resinous-punctate on the outside and microscopically puberulous, its lobes about 1 mm. long, erect, resinous-punctate on the back.

The type of this species was collected by Paul Alfred Petelot (*no. 2636*) in an open forest at about 600 m. altitude at Mount Bavi, province of Sontây, Tonkin, French Indochina, on June 4, 1940, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Clerodendrum hiulcum Moldenke, sp. nov.

Arbor parva; ramulis mediocriter gracilibus obtuse tetragonis lenticellatis, in statu juvenili densissime breviterque pubescentibus vel brunneo-puberulis, deinde glabrescentibus; foliis brunnescentibus; petiolis gracilibus dense puberulis; laminis membranaceis ellipticis

integris ad apicem acutis vel brevissime acuminatis ad basim acutis, supra leviter puberulis, subtuse dense puberulis; inflorescentiis laxe multifloris ubique dense brunneo-puberulis vel breviter pubescentibus; calyce campanulato plerumque 10-costato dense puberulo brunnescente 5-lobato.

Small tree, about 3 m. tall; branchlets and twigs medium-slender, obtusely tetragonal, compressed at the nodes on younger parts, often conspicuously lenticellate with close prominent lenticels on the older parts, very densely short-pubescent or puberulent with brownish hairs, much less so or even glabrescent on older parts in age; nodes often more or less annulate; principal internodes 1–4 cm. long; leaves decussate-opposite, brunnescent in drying; petioles slender, 8–19 mm. long, canaliculate above, densely puberulent throughout; blades membranous, somewhat lighter beneath, elliptic, 5–8 cm. long, 2–4 cm. wide, acute or very shortly acuminate at the apex, entire, acute at base, lightly puberulent above, densely puberulent beneath; midrib slender, flat or subcanaliculate above, prominent beneath; secondaries slender, 4–8 per side, arcuate-ascending, flat above, prominulous beneath; veinlet reticulation usually obscure or indiscernible above, only the largest parts subprominulous beneath; inflorescence mostly terminal or with a few pairs of cymes in the uppermost axils, loosely many-flowered, about 3 times dichotomous, very densely puberulent or short-pubescent throughout with brownish hairs; peduncles slender, 1–2 cm. long; pedicels very slender, 2–5 mm. long; foliaceous bracts often present in pairs at the base of the inflorescence-branches, mostly 1 cm. long or less; bractlets linear, 2–3 mm. long; calyx campanulate, 8–9 mm. long, 5–6 mm. wide, mostly 10-costate, densely puberulent, brunnescent in drying, its rim 5-lobed, the lobes triangular-ovate, about 3 mm. long, attenuate-acute at the apex; corolla hypocrateriform, its tube vivid-rose in color, very slender, about 2 cm. long or slightly less, very minutely pulverulent-puberulent outside above the calyx or subglabrescent, its limb white, about 1 cm. wide; stamens exserted about 1 cm. or slightly more from the corolla-mouth; pistil about equaling the stamens, glabrous; fruiting-calyx and fruit not known.

The type of this species was collected by Raymond Decary (*no. 5065*) on quartzite in a forest at Ifandana, in the province of Farafangana, Madagascar, on September 8, 1926, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum lastellei Moldenke, sp. nov.

Frutex; ramulis gracilibus griseis obtuse tetragonis saepe sulcatis parce lenticellatis glabris; petiolis gracilibus glabris; laminis coriaceis ellipticis nitidis integris ad apicem acutis vel subacuminatis ad basim acutis utrinque glabris; inflorescentiis terminalibus cymosis paucifloris glabris; calyce coriaceo stramineo valde venoso tubuloso-campanulato glabro non nigrescente.

Shrub; branchlets and twigs slender, grayish, obtusely tetragonal, often sulcate, sparsely lenticellate, glabrous; nodes not annulate; principal internodes 1.3–2.8 cm. long; leaves decussate-opposite; petioles slender, about 4 mm. long, glabrous; blades lightly coriaceous, uniformly bright-green on both surfaces, elliptic, shiny, 3–5 cm. long,

1.2–2.3 cm. wide, acute or slightly subacuminate at the apex, entire, acute at the base, glabrous on both surfaces; midrib slender, flat above, prominent beneath; secondaries very slender, 2–6 per side, irregular, ascending, arcuately joined near the margins beneath, obscure or subprominulous above, prominulous beneath; veinlet reticulation rather sparse, only the largest parts prominulous beneath, obscure above; inflorescence apparently terminal, cymose, few-flowered, usually only 3-flowered; peduncles slender, about 2.5 cm. long, glabrous, stramineous; pedicels comparatively stout, stramineous, 1.5–2 cm. long, glabrous; calyx coriaceous but not heavy, stramineous, not nigrescent, conspicuously venose, tubular-campanulate, about 2 cm. long, glabrous, its 5 lobes ovate, erect, about 5 mm. long, acute at the apex; corolla hypocrateriform, its tube very narrowly cylindric, 2 cm. long, glabrous outside, its limb about 2 cm. wide; stamens and pistil exserted 2–3 cm.

The type of this species was collected by M. de Lastelle—in whose honor it is named—somewhere in Madagascar in 1841, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum leandrii Moldenke, sp. nov.

Frutex subscandens; ramis ramulisque gracillimis obtuse tetragonis adpresso-strigillosis glabrescentibus; foliis numerosis; petiolis gracillimis vel obsoletis parce strigillosis; laminis tenuiter chartaceis nigrescentibus anguste ellipticis integris saepe subrevolutis ad apicem acutis ad basim attenuatis utrinque parce adpresso-strigillosis; inflorescentiis axillaribus 1-floris; calyce campanulato nigrescente minute puberulo vel glabro subtruncato breviter 5-denticulato.

Sprawling or clambering shrub; branches, branchlets, and twigs very slender, the older ones light-gray, the younger ones brown, obtusely tetragonal, the youngest parts appressed-strigillose with whitish or brownish antrorse hairs, glabrescent in age; nodes not annulate; principal internodes much abbreviated, mostly 2–7 cm. long; leaves decussate-opposite, numerous; petioles very slender, about 1 mm. long or obsolete, sparsely strigillose, nigrescent; leaf-blades thin-chartaceous, uniformly nigrescent on both surfaces in drying, narrow-elliptic, 1–2.5 cm. long, 3–5 mm. wide, entire, often with the margins slightly subrevolute, acute at the apex, attenuate at the base, sparsely appressed-strigillose on both surfaces with very short antrorse hairs; midrib slender, flat or subimpressed above, prominulous beneath; secondaries and veinlets indiscernible on both surfaces; inflorescence axillary, solitary, 1-flowered, usually produced below the tip of the twigs; calyx campanulate, nigrescent, 2–2.5 mm. long, 1.5–2 mm. wide, minutely puberulous or glabrate, its rim subtruncate, shortly 5-toothed; corolla white, hypocrateriform, its tube narrow-cylindric, 2.5–4 cm. long, ampliate toward the apex, minutely puberulent with very short capitate hairs, its limb 5-lobed, about 1.5 cm. wide; stamens 4, inserted at the apex of the corolla-tube, included; pistil very short, included, the style about 7 mm. long, bifid at the apex; ovary oblong, glabrous, incompletely 4-celled (or 2-celled?); fruiting-calyx split down one side, nigrescent, somewhat accrescent, about 5 mm. long, glabrate.

The type of this very distinctive species was collected by Jacques Leandri (*no. 1060*)—in whose honor it is named—on calcareous rocks,

altitude 200 m., at Tsingy du Bemaraha (9th Reserve), Madagascar, at the end of February, 1933, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris. Its short stamens and pistil and indistinct ovary structure render the generic position of this species open to question.

Clerodendrum loniceroides Moldenke, sp. nov.

Frutex; ramis ramulisque gracillimis tetragonis brunneis minute puberulis glabrescentibus; petiolis filiformibus dense flavo-puberulis et resinoso-granulosis; laminis membranaceis brunnescentibus ellipticis integris ad apicem obtusis ad basim acutis vel obtusis, supra obscure pilosulis vel glabratis, subtus minute puberulis et resinoso-punctatis; inflorescentiis terminalibus paucifloris; pedunculis pedicellisque filiformibus dense flavo-puberulis et resinosis; calyce campanulato herbaceo flavo-puberulo resinoso 5-apiculato.

Shrub; branches, branchlets, and twigs all very slender, tetragonal, light brownish, the youngest parts minutely puberulent, the older parts glabrescent, the bark readily exfoliating; nodes usually more or less annulate; principal internodes 0.7–5.5 cm. long; leaves decussate-opposite; petioles filiform, about 1 mm. long, densely yellow-puberulent and resinous-granulose; blades membranous, brunnescent in drying, much lighter beneath, elliptic, apparently less than 2 cm. long, 6–10 mm. wide, obtuse at the apex, entire, acute or obtuse at the base, very obscurely pilosulous or glabrate above, minutely puberulous and resinous-punctate beneath; midrib filiform, flat above, slightly subprominulous beneath; secondaries filiform, about 3 per side, indiscernible above, subprominulous beneath, ascending; veinlet reticulation indiscernible on both surfaces; inflorescences apparently terminal, few-flowered; peduncles very slender and abbreviated, usually about 2 mm. long, densely yellow-puberulent and resinous-granulose; pedicels filiform, about 1 mm. long, densely yellow-puberulent and resinous; calyx campanulate, herbaceous, about 1.5 mm. long and 1 mm. wide, yellow-puberulent and resinous, its rim 5-apiculate; corolla infundibular, about 7 mm. long, its limb and upper part of the tube densely yellowish-puberulent and resinous on the outside, the limb about 3 mm. wide.

The type of this very doubtful species was collected by Henri Perrier de la Bâthie (*no. 737*) in Madagascar in 1898, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris. The aspect of the plant is that of a *Lonicera*, and the available material is not sufficient to eliminate all doubt as to its correct taxonomic position.

Clerodendrum mananjariense Moldenke, sp. nov.

Frutex; ramulis gracilibus obtuse tetragonis griseis minute puberulis glabrescentibus; petiolis gracillimis subglabratis; laminis membranaceis ellipticis integris ad apicem acuminatis ad basim acutis vel acuminatis, supra obscure pulverulento-punctatis vel glabratis, subtus dense resinoso-punctatis, non nigrescentibus; inflorescentiis axillaribus terminalibusque laxe multifloris ubique minute puberulis; calyce campanulato nigrescente obscure puberulo vel glabrato subtruncato minute denticulato.

Shrub to 4 m. tall; branchlets and twigs slender, obtusely tetragonal, gray, the youngest parts minutely puberulous, the older parts glabrescent; leaf-scars very large and prominent, corky; nodes not annulate; principal internodes 7–20 mm. long; leaves decussate-opposite; petioles very slender, 5–12 mm. long, subglabrate; leaf-blades membranous, bright-green above, lighter beneath, not nigrescent, elliptic, 4–6 cm. long, 1.8–2.6 cm. wide, acuminate at the apex, entire, acute or acuminate at the base, very obscurely pulverulent-punctate above or glabrate, densely resinous-punctate beneath; midrib slender, flat above, prominulous beneath; secondaries very slender, 3–8 per side, arcuate-ascending, flat or often obscure above, subprominulous beneath; veinlet reticulation rather sparse, indiscernible above, flat beneath; inflorescence axillary and terminal, the cymes aggregated at the tips of the twigs, loosely many-flowered, minutely puberulous throughout; foliaceous bracts absent; bractlets linear-setaceous; pedicels filiform, 2–4 mm. long, puberulous; calyx campanulate, about 2 mm. long and wide, obscurely puberulous or glabrate, nigrescent, its rim subtruncate, minutely denticulate or subentire; corolla hypocrateriform, white, its tube narrow-cylindric, 6–8 mm. long, minutely pulverulent outside, its limb about 5 mm. wide; stamens and pistil violet, exserted about 1 cm. from the corolla-mouth; fruiting-calyx and fruit not known.

The type of this species was collected by Henri Perrier de la Bâthie (*no. 10192*) between Tavy and Savoka, in the neighborhood of Mananjary, altitude about 400 m., Madagascar, in January, 1913, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum mandrarense Moldenke, sp. nov.

Frutex; ramulis gracillimis griseis obtuse tetragonis glabris lenticellatis saepe compressis; petiolis gracilibus glabris; laminis chartaceis firmis nitidis ellipticis integris ad apicem acuminatis ad basim plerumque acutis utrinque glabris; inflorescentiis terminalibus et subterminalibus 1- vel 2-floris; pedicellis glabris ampliatis; calyce campanulato herbaceo venoso glabro nitido 5-lobato.

Shrub; branchlets and twigs very slender, grayish, obtusely tetragonal, glabrous, lenticellate, often compressed; nodes not annulate; principal internodes 1–5.5 cm. long; leaves decussate-opposite; petioles slender, 3–6 mm. long, glabrous, flattened and canaliculate above; leaf-blades chartaceous, rather firm, uniformly bright-green and shiny on both surfaces, elliptic, 5–9 cm. long, 1.7–4 cm. wide, acuminate at the apex, entire, mostly acute at the base, glabrous on both surfaces; midrib slender, prominulous above, prominent beneath; secondaries slender, 5–7 per side, irregular, often indistinct from the reticulation, prominulous above, prominent beneath, divaricate or arcuate-ascending, joined in many loops near the margins; veinlet reticulation abundant, conspicuous, prominulous on both surfaces; inflorescence apparently terminal or in the uppermost axils, 1- or 2-flowered; pedicels about 15 mm. long, ampliate upwards, glabrous, often curvate; bracts and bractlets obsolete; calyx broadly campanulate, herbaceous, about 3.5 cm. long and to 2 cm. wide, longitudinally venose, glabrous, shiny, its rim 5-lobed, the lobes ovate-triangular, 6–7 mm. long, attenuate-

acute at the apex; corolla infundibular, its tube about equaling the calyx and about 15 mm. broad, glabrous, its limb about 3 cm. wide when expanded; fruiting-calyx and fruit not known.

The type of this species was collected by Henri Humbert (*no. 6630 ter*) in the forest on gneiss laterite on the slopes or summit of Marosoui, in the upper basin of the Nandrare, in southeastern Madagascar, at an altitude of 1000–1400 m., on November 14 or 15, 1928, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum manombense Moldenke, sp. nov.

Frutex ramulis gracillimis obtuse tetragonis parce strigillosis; petiolis subfiliformibus plerumque glabris vel in canaliculo pilosulis; laminis membranaceis ellipticis vel elliptico-lanceolatis utrinque glabratis; inflorescentiis terminalibus cymosis multifloris; pedunculis pedicellisque filiformibus strigillosis; calyce campanulato herbaceo nigrescente glabro truncato 5-apiculato.

Shrub; branchlets and twigs very slender, obtusely tetragonal, rather sparsely strigillose; nodes more or less annulate with a band of denser hairs; principal internodes 1–4 cm. long; leaves decussate-opposite; petioles subfiliform, 1–2 cm. long, canaliculate above, mostly glabrous except for a scattered line of minute hair in the channel; blades membranous, dull-green on both surfaces, elliptic or elliptic-lanceolate, 4.5–8 cm. long, 2–3.8 cm. wide when fully developed, glabrate on both surfaces; midrib filiform, flat above, subprominulous beneath; secondaries filiform, 5–7 per side, flat or almost so on both surfaces or very slightly subprominulous, arcuate-ascending, obscurely anastomosing in loops near the margins; veinlet reticulation indiscernible or obscure on both surfaces; inflorescence terminal, cymose, many-flowered, sometimes subtended by a pair of axillary cymes; peduncles filiform, flattened, nigrescent, strigillose, 5–10 mm. long; pedicels filiform, 1–3 mm. long, strigillose; bractlets setaceous, about 1 mm. long, strigillose; calyx campanulate, herbaceous, nigrescent in drying, 1.5–2.5 mm. long, 1.5–2 mm. wide, glabrous, its rim truncate, very shortly 5-apiculate; corolla infundibular, nigrescent in drying, 7–8 mm. long in all, glabrous on the outside, its tube narrow-cylindric, its limb about 4 mm. wide; stamens and pistil exserted almost 1 cm. from the corolla-mouth.

The type of this species was collected by Henri Humbert (*no. 20004*) in tropophilous forest and xerophilous bush on limestone rocks in the gorges of the Manombo, altitude 100–350 m., in southwestern Madagascar, on January 25 or 26, 1947, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum moramangense Moldenke, sp. nov.

Frutex; ramis mediocriter gracilibus griseis subteretibus glabris; ramulis gracilibus subalbidis obtuse tetragonis plerumque sulcatis valde lenticellatis glabris; petiolis crassiusculis subglabratis; laminis coriaceis elliptico-oblanceolatis plerumque subfalcatis integris ad apicem plerumque breviter acuminatis, rare emarginatis, ad basim acutis,

utrinque glabris nitidisque, subtus inconspicue impresso-punctatis; inflorescentiis terminalibus cymosis 1–7-floris; pedunculis obsoletis vel perabbreviatis; pedicellis crassiusculis glabris; calyce herbaco oblongo-cylindrico glabro profunde 5-lobato non nigrescente.

Shrub; branches medium-slender, very light-gray, subterete, lenticellate, glabrate; branchlets slender, almost white, obtusely tetragonal, often sulcate, prominently lenticellate, glabrous throughout; nodes not annulate; principal internodes 1.5–5.3 cm. long; leaf-scars large, divergently prominent, corky; leaves decussate-opposite; petioles stoutish, 2–8 mm. long, subglabrate; leaf-blades coriaceous, elliptic-oblanceolate, 2.8–9 cm. long, 1.4–3.9 cm. wide, often slightly falcate, mostly short-acuminate at the apex, rarely emarginate, acute at the base, entire, glabrous and shiny on both surfaces, rather inconspicuously impressed-punctate beneath; midrib slender, impressed above, sharply prominent beneath; secondaries slender, 5–7 per side, often more or less impressed above, sharply prominent beneath, ascending but often arcuate only toward the margins, anastomosing in loops near the margins beneath; veinlet reticulation indiscernible above, the large parts prominulous beneath; inflorescence terminal, cymose, 1–7-flowered; peduncles extremely abbreviated or obsolete; pedicels rather stout, 5–8 mm. long, glabrous; calyx herbaceous, 2.3–2.7 cm. long, 9–12 mm. wide, not nigrescent nor brunnescent, oblong-cylindric, glabrous, its rim deeply 5-lobed, the lobes triangular-ovate, 6–10 mm. long, attenuate-acute at the apex, erect; corolla infundibular, vivid rose-colored, its tube infundibular, broadly cylindric, 3–4 cm. long, about twice as long as the calyx, greatly ampliate above, microscopically pulverulent-puberulent or glabrate outside, its lobes broadly elliptic, about 1.5 cm. long, rounded at the apex; stamens about equaling the corolla-limb; pistil slightly exserted.

The type of this species was collected by Raymond Decary (*no. 18257*) at Lakato, Moramanga district, Madagascar, on September 5, 1942, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum myrtifolium Moldenke, sp. nov.

Frutex; ramulis gracillimis obtuse tetragonis brunneis vel griseis minute puberulis glabrescentibus, in statu juvenili saepe acutiuscule tetragonis lenticellatis; foliis numerosis; petiolis gracillimis rubellis minute puberulis; laminis charteceis ellipticis vel subrotundatis pernititis integris ad apicem obtusis vel rotundatis vel emarginatis, ad basim acutis, utrinque glabris, subtus dense impresso-punctatis; inflorescentiis axillaribus terminalibusque 1–3-floris plusminusve nutantibus; pedunculis pedicellisque filiformibus minutissime puberulis; calyce campanulato herbaceo subglabro 5-costato 5-lobato.

Shrub, 4–6 m. tall, much branched; branches short; branchlets and twigs very slender, obtusely tetragonal, light brownish or grayish, minutely puberulent on the younger parts, glabrescent in age, the youngest parts often rather acutely tetragonal and sulcate, lenticellate; nodes not annulate; principal internodes much abbreviated, mostly 5–15 mm. long, sometimes elongate to 5.5 cm.; leaves decussate-opposite, abundant; petioles very slender, 2–5 mm. long, minutely

puberulent, reddish; blades chartaceous, elliptic or sometimes subrotund, bright green on both surfaces, very shiny especially above, 2.3–3.8 cm. long, 1.2–2.1 cm. wide, obtuse or rounded at the apex, rarely emarginate, entire, acute at the base, glabrous on both surfaces, densely impressed-punctate beneath; midrib very slender, flat above, prominulous beneath; secondaries filiform, 3 or 4 per side, flat above, very slightly subprominulous beneath, arcuate-ascending, anastomosing in loops at the margins beneath; veinlet reticulation indiscernible on both surfaces; inflorescence axillary in the uppermost axils or terminal, 1–3-flowered, more or less drooping; peduncles filiform, 0.5–2 cm. long, microscopically puberulent, nigrescent; pedicles filiform, 3–7 mm. long, microscopically puberulent, usually with a pair of setaceous bractlets; calyx campanulate, herbaceous, 1.4–1.7 cm. long, 9–11 mm. wide, subglabrous, 5-ribbed, its rim 5-lobed, the lobes triangular-ovate, 3–4 mm. long, acute, erect; corolla red-violet, infundibular, about 3.5 cm. long in all, its tube infundibular, microscopically scattered-puberulent or pulverulent on the outside or glabrescent, its lobes about 8 or 9 mm. long, more or less erect; stamens and style equaling the corolla-limb or slightly shorter.

The type of this species was collected by Henri Perrier de la Bâthie (*no. 10209*) in woods at Annlamuhitro, at an altitude of about 700 m., Madagascar, in April, 1907, and is deposited in the herbarium of the Muséum National d'Historie Naturelle at Paris.

Clerodendrum paucidentatum Moldenke, sp. nov.

Frutex multiramosus; ramis ramulisque gracillimis griseis tenuibus densiuscule breviterque flavido-pilosis deinde glabrescentibus; petiolis filiformibus nigrescentibus glabris vel in canaliculo pilosulis; laminis membranaceis nigrescentibus integris vel 1- vel 2-dentatis ad apicem obtusis vel subacutis ad basim acutis utrinque glabris, supra subnitidis; inflorescentiis terminalibus cymosis subcapitatis paucifloris nigrescentibus; pedunculis subobsoletis; pedicellis filiformibus dense puberulis; calyce campanulato nigrescente glabro minutissime 5-apiculato.

Shrub, 1–3 m. tall, apparently much branched; branches, branchlets, and twigs all very slender, light gray, wiry, the youngest parts rather densely short-pilose with yellowish upwardly curvate hairs, the older parts glabrous; nodes not annulate; principal internodes 0.5–2 cm. long or even more abbreviated; leaves decussate-opposite; petioles filiform, 3–5 cm. long, glabrous or sometimes pilosulous in the channel above, nigrescent; blades membranous, nigrescent in drying, 1.5–4 cm. long, 1–1.3 cm. wide, blunt or subacute at the apex, acute at the base, entire or usually with 1 or 2 coarse acute or subacute teeth at or above the middle, glabrous on both surfaces, rather shiny above; midrib very slender, flat on both surfaces or very slightly prominulous beneath; secondaries filiform, about 4 per side, mostly obscure on both surfaces; veinlet reticulation indiscernible on both surfaces; inflorescence terminal, cymose; cymes subcapitate, rather few-flowered, nigrescent in drying; peduncles obsolete or subobsolete and pilose; pedicels filiform, 1–3 mm. long, densely puberulent; bracts and bractlets absent; calyx campanulate, about 2 mm. long, nigrescent in drying, glabrous, its rim very minutely 5-apiculate-toothed; corolla white on the outside, pink within,

hypocrateriform, its tube very slender, cylindric, 1–2 cm. long, glabrous on the outside, its limb about 6 mm. wide; stamens exserted about 1 cm. from the corolla-mouth; fruiting-calyx and fruit not known.

The type of this species was collected by the Service Forestier (*no. 151*) in alluvial soil at Bevasaha, in a valley at about 100 m. altitude, Ankarafantsika (Seventh Reserve), Madagascar, in March, 1933, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum pauciflorum Moldenke, sp. nov.

Frutex; ramulis virgatis gracillimis obtuse tetragonis dense adpresso-puberulis; petiolis filiformibus adpresso-puberulis; laminis submembranaceis brunnescentibus ellipticis integris ad apicem acutis vel leviter attenuatis, ad basim acutis, utrinque sparsissime minuteque strigilloso-puberulis vel glabrescentibus; inflorescentiis terminalibus paucifloris; pedunculis pedicellisque filiformibus adpresso-puberulis; calyce campanulato apicem versus plusminusve flavido-strigoso, margine valde 5-lobato, lobis elongato-linearibus divaricato-recurvis.

Shrub; branchlets apparently virgate, very slender, obtusely tetragonal, densely appressed-puberulent with yellowish hairs; nodes not annulate; principal internodes 1.5–5 cm. long; leaves decussate-opposite; petioles filiform, 1–2 mm. long, appressed-puberulent; blades submembranous, dark green on both surfaces, brunnescent in drying, elliptic, 2.5–3.5 cm. long, 1.3–1.5 cm. wide, acute or slightly attenuate-acute at the apex, entire, acute at the base, very sparsely and minutely strigillose-puberulent on both surfaces or glabrescent; midrib very slender, flat above, subprominulous beneath; secondaries filiform, 2 or 3 per side, flat or obscure above, subprominulous beneath, arcuate-ascending; veinlet reticulation indiscernible on both surfaces; inflorescence apparently terminating very short axillary twigs, few-flowered; peduncles filiform, 1–1.5 cm. long, densely appressed-puberulent with yellowish hairs; pedicels filiform, 3–5 mm. long, minutely appressed-puberulent; bractlets obsolete; calyx campanulate, 2–2.5 mm. long, more or less yellowish-strigose toward the apex, its rim plainly 5-lobed, the lobes elongate-linear, divaricate-recurved; corolla hypocrateriform, 1 cm. long or less.

The type of this species was collected by I. Garnier between Tamatave and Tananarive, Madagascar, in 1869, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum peregrinum Moldenke, sp. nov.

Frutex multiramosus; ramis ramulisque gracillimis obtusissime tetragonis vel subteretibus fuscis glabratis lenticellatis adpresso-pubescentibus vel strigosis; petiolis gracillimis leviter strigillosis vel glabrescentibus brunnescentibus; laminis leviter chartaceis brunnescentibus ellipticis vel elliptico-ovatis integris ad apicem breviter acuminatis ad basim acutis utrinque subglabris, subtus impresso-punctatis; inflorescentiis terminalibus subcapitatis congestis nigrescentibus sessilibus; pedicellis filiformibus parce adpresso-pilosulis vel glabris; calyce angusto-campanulato nigrescente glabro truncato.

Shrub, to 2 m. tall, much branched; branches, branchlets, and twigs very slender, very obtusely tetragonal or subterete, blackish, glabrate, marked with numerous elevated whitish corky lenticels, the youngest parts appressed-pubescent or strigose with very short brownish or stramineous antrorse hairs; nodes not annulate; principal internodes much abbreviated on twigs, mostly 2–10 mm. long, elongated on older wood to 4.5 cm.; leaves decussate-opposite, brunnescent in drying; petioles very slender, 2–5 mm. long, slightly strigillose or glabrescent, brunnescent, flat above; blades thin-chartaceous, uniformly dark green on both surfaces and brunnescent in drying, elliptic or elliptic-ovate, 2–4 cm. long, 1–2.3 cm. wide, short-acuminate at the apex, entire, mostly acute at the base, glabrous or subglabrate on both surfaces, somewhat impressed-punctate beneath; midrib slender, flat on both surfaces or subprominulous beneath; secondaries filiform, about 3 per side, indiscernible above, barely discernible beneath, arcuate-ascending, not anastomosing; veinlet reticulation mostly indiscernible on both surfaces; inflorescences terminal, subcapitate, few- or rather many-flowered, congested, nigrescent in drying, sessile; pedicels filiform, mostly 1–2 mm. long, sparsely appressed-pilosulous or glabrous, nigrescent; foliaceous bracts absent; bractlets obsolete or very minute and setaceous; calyx narrow-campanulate, 2–3 mm. long, about 1 mm. wide, nigrescent, glabrous, its rim truncate and subentire; corolla white, hypocrateriform, its tube narrow-cylindric, 12–20 mm. long, about 1 mm. wide or less, its limb about 8 mm. wide; stamens inserted in the upper ¼ of the corolla-tube, exserted about 7 mm. from its mouth, the exserted portion violet; anthers oblong; pistil to 3.5 cm. long; fruiting-calyx and fruit not known.

The type of this species was collected by Henri Perrier de la Bâthie in Madagascar in 1898, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum perrieri Moldenke, sp. nov.

Frutex valde sarmentosus; ramulis sarmentisque gracillimis subteretibus brunneis dense patenteque pubescentibus subglabrescentibus; foliis oppositis vel ternatis; petiolis gracillimis dense patenteque pubescentibus; laminis chartaceis late ellipticis vel elliptico-ovatis non brunnescentibus, ad apicem obtusis vel rotundatis ad basim acutis usque ad rotundatis, integris vel irregulariter subsinuosis, utrinque dense patenteque pubescentibus, subtus punctatis; inflorescentiis terminalibus capitatis densissime multifloris; calyce campanulato densiuscule patenteque pubescente breviter 5-dentato.

Shrub, apparently very twiggy; branchlets and twigs very slender, subterete, brownish, densely spreading-pubescent, less so in age, the older wood subglabrate; nodes often more or less annulate; principal internodes abbreviated, 0.7–4 cm. long; leaves decussate-opposite or ternate; petioles very slender, 2–6 mm. long, densely spreading-pubescent; leaf-blades chartaceous, bright-green, somewhat lighter beneath, not nigrescent nor brunnescent in drying, broadly elliptic or elliptic-ovate, sometimes suborbicular, 0.7–2 cm. long (usually less than 2 cm. long), 5–16 mm. wide, obtuse or rounded at the apex, varying from rounded to acute at the base, entire or slightly and irregularly sub-

sinuate, rather densely spreading-pubescent on both surfaces, punctate beneath; midrib filiform, flat and often obscure above, subprominulous beneath; secondaries filiform, 3 or 4 per side, ascending, mostly indiscernible above, slightly subprominulous beneath; veinlet reticulation indiscernible on both surfaces; inflorescence terminal, capitate, very densely many-flowered, 1.5–5.6 cm. wide; peduncles obsolete; cyme-branches filiform, densely spreading-pubescent, 1–5 mm. long, mostly obsolete; pedicels obsolete or filiform and about 1 mm. long, very densely spreading-pubescent; calyx campanulate, about 2 mm. long and wide, rather densely spreading-pubescent, its rim very shortly 5-toothed; corolla white, hypocrateriform, its tube very slender, about 1 cm. long, glabrate outside, its limb about 7 mm. wide; stamens and pistil exserted about 1 cm. from the corolla-mouth, the filaments rose, the anthers brown or blackish; fruiting-calyx and fruit not known.

The type of this species was collected by Henri Humbert (*no. 20214*) in a tropophilous forest on schist, forest of Sakoa, basin of the Onilahy, Madagascar, at an altitude of about 300 m., on February 10 or 11, 1947, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum perrieri var. **laxicymosum** Moldenke, var. nov.

Haec varietas a forma typica speciei recedit inflorescentiis laxe patentibus, pedunculis gracillimis usque ad 2.5 cm. longis, et pedicellis filiformibus usque ad 1 cm. longis.

This variety differs from the typical form of the species in having its inflorescence at time of anthesis open and loosely spreading, the very slender peduncles often up to 2.5 cm. long and the filiform pedicels to 1 cm. long.

The type of this variety was collected by Raymond Decary (*no. 8533*, in part) at Ambovombe, Madagascar, in February, 1931, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris. The type sheet consists of a mixture of this plant and of *C. emirnense* Bojer. The three pieces of the latter are marked "a," while the two which constitute the type of this variety are lettered "b."

Clerodendrum perrieri var. **macrophyllum** Moldenke, var. nov.

Haec varietas a forma typica speciei recedit laminis foliorum maturis usque ad 4.5 cm. longis et 2.8 cm. latis.

This variety differs from the typical form of the species in having its mature leaf-blades to 4.5 cm. long and 2.8 cm. wide.

The type was collected by Henri Humbert (*no. 20145*) in the tropophilous forest and xerophilous bush on limestone rocks at Vallon d'Andranolahy, in the valley of the Onilahy, near Tongobory, Madagascar, at an altitude of 50 to 200 m., on February 5, 1947, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum premnoides Moldenke, sp. nov.

Frutex; ramulis gracillimis brunneis suberoso-lenticellatis obtuse tetragonis parce strigillosis glabrescentibus; petiolis filiformibus densiuscule strigillosis; laminis membranaceis oblongo-ovatis integris ad

apicem brevissime acuminatis, ad basim truncatis vel subtruncatis utrinque obscure strigillosis, subtus punctatis; inflorescentiis terminalibus cymosis dense multifloris; pedicellis cinereo-tomentellis; calyce herbaceo campanulato parce strigilloso-pubescente subtruncato.

Shrub, 2–3 m. tall; branchlets and twigs very slender, light brownish, corky-lenticellate, obtusely tetragonal, sparsely strigillose, glabrescent in age; nodes not annulate; principal internodes 0.3–3.5 cm. long, mostly very much abbreviated; leaf-scars large, divaricate, corky, almost circular, conspicuous; leaves decussate-opposite; petioles filiform, 1–2 cm. long, rather densely strigillose; blades membranous, oblong-ovate, rather uniformly bright green on both surfaces, not nigrescent, 5–8 cm. long when fully developed and 2.5–5 cm. wide, very shortly acuminate at the apex, entire, truncate or subtruncate at the base (rarely oblique), rather obscurely strigillose on both surfaces, punctate beneath, more densely strigillose when immature; midrib slender, flat above, very slightly subprominulous beneath; secondaries filiform, 5–8 per side, flat on both surfaces, arcuate-ascending, obscurely anastomosing at the margins; veinlet reticulation mostly indiscernible above and obscure beneath; inflorescence terminal, cymose, densely many-flowered; peduncles much abbreviated or obsolete; inflorescence-branches and sympodia densely whitish- or cinereous-tomentellous, much abbreviated or the lowermost branches filiform and to 1.5 or 2 cm. long; pedicels filiform, 1–2 mm. long, cinereous-tomentellous; calyx herbaceous, campanulate, 1.5–2 mm. long, rather sparsely strigillose-pubescent, about 1 mm. wide, its rim subtruncate but with 5 very short tooth-like apiculations; corolla hypocrateriform, white, its tube very narrowly cylindric, about 5 mm. long, pilose on the outside, its limb 3–4 mm. wide; stamens and pistil exserted 5–7 mm. from the corolla-mouth.

The type of this species was collected by Henri Perrier de la Bâthie (*no. 10290*) in the woods of Namoroka, near Andronomova, Ambongo, Madagascar, in October, 1903, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum roseiflorum Moldenke, sp. nov.

Arbor; ramulis irregularibus obtuse tetragonis griseis subprominente lenticellatis leviter obscureque puberulis glabrescentibus; petiolis gracilibus nigrescentibus canaliculatis obscure minuteque puberulis vel glabrescentibus; laminis leviter chartaceis vel submembranaceis brunnescentibus ellipticis integris ad apicem acutis vel subacuminatis, ad basim acutis, utrinque minutissime pulverulento-puberulis; inflorescentiis axillaribus plerumque 1–3-floris; pedunculis pedicellisque gracillimis brunnescentibus obscure pulverulentis; calyce coriaceo campanulato brunnescente minutissime strigilloso-puberulo vel pulverulento 5-lobato.

Tree, 15–20 m. tall; branchlets and twigs irregular, obtusely tetragonal, light gray, often lichen-encrusted, the very youngest parts nigrescent in drying, rather prominently lenticellate, very finely and obscurely puberulent, glabrescent in age; leaf-scars rather large, corky, elevated, almost circular; nodes not annulate; principal internodes mostly abbreviated, 2–7 mm. long; leaves decussate-opposite; petioles slender, nigrescent in drying, 5–14 mm. long, canaliculate and flattened

above, very obscurely and minutely puberulent or glabrescent; blades thin-chartaceous or submembranous, brunnescent in drying, lighter beneath, elliptic, 3–6.5 cm. long, 1.5–2.5 cm. wide, acute or subacuminate at the apex, entire, often very slightly subrevolute along the margins in drying, acute at the base, very obscurely and minutely pulverulent-puberulent on both surfaces; midrib slender, flat above, prominent beneath; secondaries very slender, 5–7 per side, arcuate-ascending, obscure or the base of the lower ones slightly prominulous above, rather sharply prominulous throughout beneath and anastomosing in many loops near the margins; veinlet reticulation indiscernible above, sparse and mostly plane beneath; inflorescence axillary, mostly 1–3-flowered, 2 per node, mostly surpassing the subtending leaves when in full anthesis; peduncles very slender, 2.5–4.5 cm. long, brunnescent in drying, very minutely and obscurely puberulent-pulverulent; pedicels filiform, 4–7 mm. long, very obscurely pulverulent or glabrescent, brunnescent; calyx coriaceous, campanulate, 7–8 mm. long, slightly wider than long, brunnescent in drying, very minutely and obscurely strigillose-puberulent or pulverulent, its rim 5-lobed, the lobes tooth-like, ovate-triangular, 1.5–2 mm. long, attenuate-acute; corolla rose, hypocrateriform, its tube narrow-cylindric, 2.4–2.8 cm. long, ampliate at the apex, obscurely pulverulent outside, its limb 2–2.5 cm. wide.

The type of this species was collected by Henri Perrier de la Bâthie (*no. 16434*) in forests at 2000 m. altitude, Tranatanana, Madagascar, in April, 1934, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum rubellum var. **anomalum** Moldenke, var. nov.

Haec varietas a forma typica speciei recedit calyce late campanulato et tubo corollae calyce aequante vel paullo excedente.

This variety differs from the typical form of the species in having its calyx at time of anthesis broadly campanulate and the corolla-tube equaling or only slightly surpassing the calyx.

The type was collected somewhere in Madagascar, but the name of the collector is not known. The type sheet is one from the Hooker Herbarium deposited in 1867 in the herbarium of the Royal Botanic Gardens at Kew.

Clerodendrum sakaleonense Moldenke, sp. nov.

Frutex; ramulis mediocriter crassis vel gracilibus stramineis vel griseobrunneis obtuse tetragonis vel multi-angulatis longitudinaliter striato-sulcatis minute puberulis; foliis verticellatis; petiolis gracilibus minute pulverulento-puberulis vel glabrescentibus brunnescentibus; laminis membranaceis subbrunnescentibus elliptico-ovatis vel obovato-ellipticis integris ad apicem breviter acuminatis, ad basim plusminusve acuminatus, utrinque glabris, subtus dense resinoso-punctatis; inflorescentiis axillaribus terminalibusque, cymis laxis multifloris aggregatis bis vel ter dichotomis ubique minute puberulis; calyce campanulato minute puberulo truncato.

Shrub; branchlets and twigs medium-stout or slender, stramineous or grayish-brown, obtusely tetragonal or many-angled, longitudinally

striate-sulcate, minutely puberulent; nodes mostly annulate; principal internodes 2–6 cm. long; leaves whorled, 3 or 4 per node; petioles slender, 6–20 mm. long, minutely pulverulent-puberulent or glabrescent, brunnescent; blades membranous, bright green, somewhat lighter beneath and somewhat brunnescent in drying, elliptic-ovate or obovate-elliptic, 4.5–10 cm. long, 2–4.5 cm. wide, mostly short-acuminate at the apex, entire, more or less acuminate at the base, glabrous on both surfaces but densely resinous-punctate beneath; midrib slender, flat above, prominent beneath; secondaries slender, 3–6 per side, arcuate-ascending, flat above, prominulous beneath, not plainly anastomosing; veinlet reticulation very slender, sparse, mostly obscure or indiscernible on both surfaces; inflorescence axillary and terminal, the lax and open rather many-flowered cymes mostly aggregated at the tips of the twigs, the cymes mostly 2 or 3 times dichotomous, minutely puberulent throughout; peduncles and cyme-branches to 3 cm. long, compressed, puberulent; pedicels very slender or filiform, 2–7 mm. long, compressed, puberulent; calyx campanulate, 1.5–2.5 mm. long and wide, minutely puberulent, its rim truncate, very minutely short-apiculate; corolla white or rose, hypocrateriform, its tube narrow-cylindric, 5–10 mm. long, resinous-punctate on the outer surface, its limb about 1 cm. wide; stamens and pistil exserted about 13 mm. from the corolla-mouth; fruiting-calyx and fruit not known.

The type of this species was collected by Raymond Decary (*no. 14184*) in the savoka formation of the eastern forest in the Vallée du Sakaleone, Madagascar, on June 11, 1939, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum serratum var. **glabrescens** Moldenke, var. nov.

Haec varietas a forma typica speciei recedit pedunculis ramisque inflorescentii pedicellisque glabrescentibus.

This variety differs from the typical form of the species in having the peduncles, inflorescence-branches, and pedicels glabrescent.

The type was collected by Bernier on the island of Réunion in about 1834, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum subtruncatum Moldenke, sp. nov.

Frutex dumosus multiramosus; ramis ramulisque gracillimis subteretibus dense strigoso-tomentellis glabrescentibus; foliis minimis numerosis caducis; petiolis filiformibus albo-strigosis; laminis leviter chartaceis late elliptico-ovatis vel subrotundis integris ad apicem rotundatis, ad basim rotundatis vel rare subacutis, utrinque obscure minuteque strigillosis vel glabris et densissime impresso-punctatis; inflorescentiis terminalibus subcapitatis dense multifloris.

Bushy shrub, apparently much branched; branches, branchlets, and twigs very slender, subterete, the younger parts densely strigose-tomentellous with short, white, matted hairs, the older wood glabrescent and gray and lenticellate; nodes not annulate; principal internodes 4–35 mm. long, mostly much abbreviated; leaves decussate-opposite, very small, numerous, caducous; petioles filiform, 2–10 mm. long,

white-strigose with antrorse hairs like the twigs; leaf-blades rather uniformly green on both surfaces or slightly lighter beneath, thin-chartaceous, broadly elliptic-ovate or subrotund, 2–14 mm. long, 2–10 mm. wide, rounded at the apex, entire, rounded or rarely subacute at the base, very obscurely and minutely scattered-strigillose or glabrous on both surfaces, very densely impressed-punctate on both surfaces; midrib filiform, flat or obscure on both surfaces; secondaries filiform, 2 or 3 per side, mostly obscure or indiscernible above, flat or obscure beneath, arcuate-ascending; veinlet reticulation indiscernible; inflorescence terminal, subcapitate, densely many-flowered, to 2 cm. long and 3 cm. wide, sometimes slightly more lax with 3 or 4 pairs of small cymes obvious; primary peduncle obsolete, secondary peduncles and rachis densely white-strigose or tomentellous, the former filiform and to about 7 mm. long; foliaceous bracts absent; bractlets setaceous, about 1 mm. long, strigose; pedicels filiform, 1–2 cm. long, white-pubescent; calyx campanulate, about 2 mm. long and 1.5 mm. wide, very sparsely strigillose or pilosulous, usually brunnescent, its rim truncate, entire or very obscurely and minutely subapiculate; corolla white, hypocrateriform, its tube very slender, about 5 mm. long, minutely pulverulent outside, its limb about 4 mm. wide; stamens and pistil exserted about 4 mm. from the corolla-mouth.

The type of this species was collected by Henri Humbert (*no. 12833*) in xerophilous bush on Mounts Kotriha and Isomonobe, in the vicinity of Isomono, Manambolo valley, Madagascar, in December, 1933, or January, 1934, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum subtruncatum f. **magnifolium** Moldenke, f. nov.

Haec forma a forma typica speciei recedit laminis foliorum plerumque 1.5 cm. longis vel longioris.

This form differs from the typical form of the species in having its leaf-blades mostly 1.5 cm. long or longer when mature.

The type was collected by André Seyrig (*no. 442*) in the neighborhood of Ampandrandava, between Bekily and Tsivory, Madagascar, in January, 1943, and is deposited in the herbarium of the Royal Botanic Gardens at Kew.

Clerodendrum sylvestre Moldenke, sp. nov.

Frutex; ramulis graciliusculis griseis obtuse tetragonis valde lenticellatis dense puberulis; petiolis gracilibus minute puberulis; laminis membranaceis late ellipticis integris non nigrescentibus ad apicem plerumque acuminatis, ad basim obtusis, utrinque minute puberulis; inflorescentiis terminalibus cymosis paucifloris bis vel ter dichotomis dense puberulis; calyce tubuloso-campanulato membranaceo non nigrescente venoso minute puberulo 5-lobato.

Shrub, 3–4 m. tall; branchlets rather slender, gray, obtusely tetragonal, prominently lenticellate, densely puberulent; leaf-scars rather large and elevated; leaves decussate-opposite; petioles slender, 4–11 mm. long, minutely puberulent, canaliculate above; leaf-blades membranous, uniformly green on both surfaces, not nigrescent in

drying, broadly elliptic, 6.5–16 cm. long, mostly 4.5–7 cm. wide, mostly acuminate at the apex, acute or obtuse at the base, minutely puberulent on both surfaces, entire; midrib very slender, flat above, prominent beneath; secondaries filiform, 5–12 per side, arcuate-ascending, flat above, prominulous beneath, anastomosing in many loops near the margins beneath; veinlet reticulation very delicate, sparse, mostly only the tertiaries plainly discernible beneath; inflorescence terminal, cymose; cymes few-flowered, mostly 2 or 3 times dichotomous, 7 cm. or less in length; peduncles mostly abbreviated, densely puberulent; cyme-branches 1–2 cm. long, densely puberulent, often ampliate above; pedicels filiform, 4–6 mm. long, densely puberulent; bracts few, oblanceolate, 10–12 mm. long, puberulent on both surfaces, long-stipitate, 2–3 mm. wide; bractlets linear, 3–5 mm. long, puberulent; calyx tubular-campanulate, 1.7–2 cm. long, 9–12 mm. wide, membranous, herbaceous, not nigrescent, somewhat venose, minutely puberulent, the 10 parallel veins ending at the sinuses and tips of the 5 lobes of the rim, the lobes triangular-ovate, 2–3 mm. long, acute at the apex; corolla hypocrateriform, rose, its tube infundibular, about 2 cm. long, equaling the calyx, broadly ampliate above, very minutely scattered-puberulent or glabrate outside, its limb 5-lobed, the lobes 1–1.3 mm. long, minutely scattered-puberulent on both surfaces.

The type of this species was collected by Henri Perrier de la Bâthie (*no. 10254*) in woods at an altitude of 200 m. along the Anovi river on the east coast of Madagascar in September, 1912, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum tubulosum Moldenke, sp. nov.

Frutex brachiatus; ramulis gracilibus griseis obtuse tetragonis saepe complanatis plusminusve minute puberulis glabrescentibus; foliis oppositis vel approximatis; petiolis gracilibus plusminusve minute puberulis; laminis membranaceis oblanceolatis integris ad apicem acuminatis, ad basim attenuato-acutis, utrinque subglabratis; inflorescentiis terminalibus cymosis valde abbreviatis subfasciculatis paucifloris; pedunculis pedicellisque dense puberulis rubris; calyce tubuloso membranaceo rubro minute pubescente 5-lobato.

Branching shrub, 3–4 m. tall; branchlets and twigs slender, grayish, obtusely tetragonal, often somewhat flattened, the youngest parts more or less minutely puberulent, the older parts glabrescent; nodes not annulate; principal internodes 5–15 mm. long; leaf-scars large, prominent, corky; leaves decussate-opposite or approximate; petioles slender, 4–12 mm. long, more or less minutely puberulent, flattened and canaliculate above; leaf-blades membranous, rather uniformly green on both surfaces, oblanceolate, 5.5–12 cm. long, 2–3.9 cm. wide, acuminate at the apex, entire, attenuate-acute at the base, practically glabrous on both surfaces; midrib very slender, prominulous and often very minutely puberulent above, prominulous beneath; secondaries filiform, 7–12 per side, arcuate-ascending, very slightly prominulous on both surfaces; veinlet reticulation very fine, abundant, slightly subprominulous on both surfaces; inflorescence apparently terminal, cymose, the cymes much abbreviated, almost fasciculate, few-flowered; peduncles greatly abbreviated, usually 1–3 mm. long, densely puberulent; pedicels

filiform, 6–10 mm. long, red, densely puberulent; bractlets few, oblong, 3–5 mm. long, puberulent; calyx tubular, membranous, red, 1–1.2 cm. long, 5–7 mm. wide, minutely puberulent outside, its rim 5-lobed, the lobes triangular-ovate, erect, acute, 2–3 mm. long; corolla infundibular, white, its tube rather broadly cylindric, ampliate above, curvate, about 2.4 cm. long, its limb about 2 cm. wide.

The type of this species was collected in woods at 300 m. altitude at Masoala, on the east coast of Madagascar, in August, 1912, by Henri Perrier de la Bâthie (*no. 10322*), and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum villosicalyx Moldenke, sp. nov.

Frutex vel arbor; ramulis gracilibus griseis vel stramineis minutissime obscureque puberulis glabrescentibus; petiolis graciusculis minute obscureque puberulis glabrescentibus; laminis coriaceis ellipticis integris utrinque nitidis ad apicem breviter acuminatis, ad basim obtusis vel rotundatis, utrinque subglabris, subtus impresso-punctatis; inflorescentiis terminalibus subpaucifloris abbreviatis congestis; pedunculis pedicellisque flavo-villosis; calyce herbaceo campanulato profunde lobato adpresso-villoso.

Shrub or tree; branchlets and twigs slender, light gray or the youngest parts more or less stramineous, very minutely and obscurely puberulous on the youngest parts, soon glabrescent, obscurely tetragonal; nodes not annulate; principal internodes 1.5–4.5 cm. long; leaves decussate-opposite, apparently borne only at the tips of the twigs; petioles rather slender, 5–10 mm. long, minutely and obscurely puberulous or glabrescent, flattened and canaliculate above; blades coriaceous, bright green and shiny on both surfaces, elliptic, 3.5–7 cm. long, 1.8–3 cm. wide, short-acuminate at the apex, obtuse or rounded at the base, entire, subglabrous on both surfaces, impressed-punctate beneath; midrib slender, flat above, prominent beneath; secondaries slender, about 5 per side, flat above, prominent beneath, divaricately spreading, hardly ascending, anastomosing in flattened loops near the margins; veinlet reticulation very fine and abundant, often rather obscure above but conspicuous beneath; inflorescence apparently terminal, rather few-flowered, abbreviated, congested but not capitate nor involucrate, shorter than the subtending leaves; peduncles very short, to 5 mm. long, yellow-villous; pedicels slender, 3–5 mm. long, yellow-villous; bractlets obsolete; calyx herbaceous, campanulate, 9–12 mm. long, 5–7 mm. wide, lobed almost to the base, its tube appressed-villous with yellowish antrorse hairs, the lobes about 7 mm. long, ovate-lanceolate, more sparsely appressed-villous, attenuate-acute or subacuminate at the apex; corolla white; ovary tetragonal, about 2 mm. long and wide, glabrous, 4-lobed.

The type of this species was collected by G. F. Scott Elliot (*no. 2827*) at Fort Dauphin, Madagascar, in June, before the year 1890, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Clerodendrum vinosum Moldenke, sp. nov.

Frutex; ramulis crassiusculis obtuse tetragonis griseis parce pilosis vel glabrescentibus lenticellatis; petiolis crassiusculis glabris; laminis

membranaceis brunnescentibus oblanceolatis vel obovatis integris, ad apicem abrupte cuspidato-acuminatis, usque ad basim gradatim attenuato-acutis, utrinque glabris; inflorescentiis elongatis nutantibus racemiformibus sed cymoso-furcatus paucifloris; calyce campanulato firme herbaceo valde lobato nigrescente glabrato.

Shrub; branchlets and twigs rather stoutish, obtusely tetragonal, grayish, sparsely pilosulous or soon glabrescent, lenticellate; nodes not annulate; principal internodes to 4 cm. long on branchlets, more abbreviated on young twigs; leaf-scars large, oblong, with thin sharp edges; leaves decussate-opposite; petioles rather stoutish, about 1.5 cm. long, glabrous, deeply canaliculate above; blades membranous, brunnescent in drying, somewhat lighter beneath, oblanceolate or obovate, 17.5–25 cm. long, 4.5–6.7 cm. wide, abruptly cuspidate-acuminate at the apex, entire, gradually attenuate from the widest part to the acute base, glabrous on both surfaces, dark green when fresh and more or less spotted with wine-red beneath; midrib flat or slightly impressed above, prominent beneath; secondaries filiform, about 7 per side, plane and usually obscure above, prominulous beneath, arcuate-ascending, anastomosing in several elongate loops near the margins; veinlet reticulation very sparse, indiscernible above, all except the largest parts obscure beneath; inflorescence elongate, drooping, racemiform but cymosely furcate with the branches making 180° angles with the axis, few-flowered; peduncles very slender, flattened, nigrescent in drying, very minutely and sparsely puberulent, 3–10 cm. long; sympodia and inflorescence-branches similar to the peduncle in all respects but only 2.5–4.5 cm. long; pedicels slender, 2–4 mm. long, puberulent, usually bearing a pair of linear bractlets 1–3 mm. long; calyx campanulate, firmly herbaceous, 14–15 mm. long, 8–10 mm. wide, lobed for about one-third its length, olive-green tinted with rose when fresh, nigrescent in drying, glabrate, its lobes triangular-ovate, about 5 mm. long, acute at the apex, erect; corolla pale sulphur-yellow; stamens and style pale sulphur-yellow.

The type of this very curious species was collected by Henri Humbert (*no. 20564*) in a dark forest on laterite and granite in the neighborhood of Ampassimena, in the valley of Manampanihy, southeastern Madagascar, altitude 20 to 100 m., between March 18 and 23, 1947, and is deposited in the herbarium of the Muséum National d'Histoire Naturelle at Paris.

Epilobium hornemanii f. **album** Moldenke, f. nov.

Haec forma a planta typica speciei corollis albis recedit.

This form differs from the typical form of the species in having white corollas.

The type was collected by Alma L. and Harold N. Moldenke (*no. 21142*) in boggy ground near a small pond in low birch forest of the subalpine belt, near Björkliden, Swedish Lappland, on July 29, 1950, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Gymnadenia conopsea var. **lapponica** f. **albiflora** Moldenke, f. nov.

Haec forma a planta typica varietatis floribus albis recedit.

This form differs from the typical form of the variety in having white flowers.

The type was collected by Alma L. and Harold N. Moldenke (*no. 21149*) on Mount Nuolja, near Abisko, Swedish Lappland, on July 23, 1950, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Leptasea aizoides f. **crocea** (Gaud.) Moldenke, comb. nov.

Saxifraga aizoides β crocea Gaud., Fl. Helv., *3*: 102. 1828.

Lippia arechavaletae var. **microphylla** Moldenke, var. nov.

Haec varietas a forma typica speciei recedit foliis uniforme parvioribus oblongo-ellipticis 6–13 mm. longis, 2.5–7 mm. latis, imbricatis integris paullo subrevolutis.

This variety differs from the typical form of the species in having its leaves uniformly smaller, oblong-elliptic, 6–13 mm. long, 2.5–7 mm. wide, imbricate, entire, and very slightly subrevolute along the margins.

The type was collected by Padre B. Rambo (*no. 2751*) in dry thickets at Morro dos Bois near São Leopoldo, Rio Grande do Sul, Brazil, on September 9, 1936, and is deposited in the herbarium of the Colegio Anchieta at Porto Alegre, Brazil.

Lippia ramboi Moldenke, sp. nov.

Frutex divaricato-ramosus; ramulis stramineis obtuse tetragonis, in lateris 2 strigillosis, in lateris 2 glabris; petiolis gracilibus glabris; laminis firme chartaceis ellipticis vel elliptico-obovatis, ad apicem acutis, ad basim cuneato-attenuatis vel acuminatis, serratis, supra pilosulo-scabrellis, subtus subglabris dense punctatis; inflorescentiis axillaribus subcapitato-spicatis oppositis; pedunculis tetragono-angulosis, lateris 2 puberulis; bracteolis magnis foliaceis.

Divaricately branched shrub, about 3 m. tall; branchlets and twigs slender, stramineous, obtusely tetragonal, strigillose on two opposite sides, glabrate on the 2 other sides; nodes annulate, principal internodes 2.5–5 cm. long; leaves decussate-opposite; petioles slender, 2–4 mm. long, glabrous; blades firmly chartaceous, grayish-green above, lighter beneath, elliptic or elliptic-obovate, acute at the apex, cuneate-attenuate or acuminate at the base, serrate from about the middle to the apex, pilosulous-scabrellous with bulbous-based hairs above, subglabrous but densely punctate beneath, occasionally with a few scattered short white hairs on the venation; midrib slender, subimpressed above, sharply prominent beneath; secondaries very slender, 2–5 per side, subimpressed above, sharply prominent beneath; veinlet reticulation indiscernible above or the largest parts subimpressed, plainly visible but not at all elevated beneath; inflorescence axillary, subcapitate-spicate, 2 per node, abundant, shorter than the subtending leaves; peduncles rather stoutish, tetragonal-angular, 13–20 mm. long, subglabrate or minutely puberulous on 2 opposite sides; spikes very densely subcapitate, to 1 cm. long and 1.5 cm. wide; bractlets large, foliaceous, conspicuous, the lowest ones elliptic, to 8 mm. long and 4 mm. wide, firmly chartaceous, obtuse at the apex, strigillose-scabrellous above and punctate beneath like the leaves, the upper ones smaller and more

conspicuously appressed-strigillose on the back; calyx about 2.8 mm. long, densely hirsutulous-pubescent, plainly lobed; corolla about 5 mm. long, densely strigose on the outside, its limb very short.

The type of this species was collected by my good friend and colleague, Padre Balduin Rambo (*no. 46306*)—in whose honor it is named—in an *Araucaria* grove at São Francisco de Paulo, Rio Grande do Sul, Brazil, on March 13, 1950, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Lippia turnerfolia var. **sessilifolia** Moldenke, var. nov.

Haec varietas a forma typica speciei recedit foliis sessilibus oblongo-ellipticis 2–4 cm. longis, 6–9 mm. latis.

This variety differs from the typical form of the species in having its leaves sessile, oblong-elliptic, 2–4 cm. long, and 6–9 mm. wide.

The type was collected by Padre B. Rambo (*no. 28180*) in shrubby fields at Nonoai on the central Rio Uruguay, Rio Grande do Sul, Brazil, on March 3, 1945, and is deposited in the herbarium of the Colegio Anchieta at Porto Alegre, Brazil.

Paepalanthus hatschbachi Moldenke, sp. nov.

Herba parva caulescens; caulibus gracilibus dense foliosis densissime albo-villosis; foliis nitidis non pellucidis, in statu juvenili plusminusve breviter villosis, deinde utrinque minutissime pulverulento-puberulis vel glabrescentibus obtusis; vaginis parcissime villosulis vel glabrescentibus, limbo 3-partito lobis lanceolatis erectis acutis; pedunculis 1 vel 2 filiformibus stramineis 4- vel 5-costatis parcissime villosulis vel glabrescentibus; capitulis albis hemisphaericis vel deinde globosis.

Small caulescent herb; stems slender, apparently 2–4.5 cm. long, densely foliose, very densely white-villous; leaves thin-membranous, uniformly light green on both surfaces, not pellucid, shiny, more or less short-villous on the upper surface when immature, merely microscopically pulverulent-puberulent on both surfaces when mature or even glabrescent, obscurely 3-veined, blunt at the apex; sheaths 2–2.5 cm. long, very sparsely villosulous or glabrescent, slender, the limb mostly 3-parted, erect, the lobes about 2 mm. long, lanceolate, acute; peduncles 1 or 2 per plant, filiform, stramineous, 14–17 cm. long, marked with a very few scattered villosulous hairs or glabrescent, 4- or 5-costate; heads hemispheric or eventually globose, about 6 mm. in diameter, white; involucral bractlets concave, brown, obovate, about 2.5 mm. long and 1.5 mm. wide, acute at the apex, more or less ciliolate-margined toward the apex, otherwise glabrous, receptacle white-villous; receptacular bractlets oblong-oblanceolate, brown, about 2.1 mm. long and 0.5 mm. wide, somewhat concave-navicular, abruptly acute at the apex, densely white-barbate at the apex; staminate florets: sepals 3, connate only at the very base or separate, brown, elliptic-oblanceolate, about 2 mm. long and 0.7 mm. wide, obtuse and densely white-barbellate at the apex, otherwise glabrous; petals connate only at the base into a short hyaline tube 1–2 mm. long, which soon splits, the free terminal portions very distinct, hyaline, appressed to the filaments, blunt, glabrous; stamens 3, the filaments about 2 mm. long, glabrous, exserted;

anthers white, composed of 2 distinct often separate thecae, each 2-celled; rudimentary 3-lobed pistil in center very short, densely villosulous-fringed; pistillate florets: sepals 3, exactly similar to those of the staminate florets; petals 3, free and separate, white-hyaline, oblanceolate, about 2 mm. long and 1 mm. wide, acute at the apex, densely villous on the back with antrorse white hairs; pistil about 2.5 mm. long; ovary 3-sulcate, 3-celled, glabrous, stramineous, 3-ovulate; style about 0.5 mm. long, surmounted by 3 stigmas and 3 style-appendages which are erect and about 1 mm. long.

The type of this species was collected by Gert Hatschbach (*no. 1743*)—in whose honor it is named—at Pico Olimpo, at an altitude of 1547 m., in the municipality of Morretes, Paraná, Brazil, on January 15, 1950, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Teijsmanniodendron peteloti Moldenke, sp. nov.

Arbor; ramulis gracilibus obtuse tetragonis griseo-brunneis saepe sulcatis glabris; nodis ampliatis; foliis oppositis simplicibus; petiolis gracilibus glabris; laminis chartaceis ellipticis vel elliptico-obovatis integris, ad apicem acuminatis, ad basim attenuato-acuminatis, utrinque glabris valde nitidisque; inflorescentiis axillaribus cymosis plerumque 4-floris glabris nigrescentibus; calyce campanulato subtruncato, margine brevissime 5- vel 6-apiculato-dentato.

Tree, 8–10 m. tall; branchlets and twigs rather slender, grayish-brown, obtusely tetragonal, the youngest parts often sulcate, glabrous, the bark apparently wrinkling and exfoliating in drying; nodes annulate, somewhat swollen; principal internodes 2.5–7.5 cm. long; leaves decussate-opposite, simple; petioles slender, 5–10 mm. long, canaliculate above, glabrous; blades chartaceous, uniformly dark green on both surfaces or slightly lighter beneath, elliptic or elliptic-obovate, 7.5–14.5 cm. long, 2.5–6 cm. wide, acuminate at the apex, entire, attenuate-acuminate into the petiole at the base, glabrous and very shiny on both surfaces; midrib slender, flat above, prominent beneath; secondaries slender, 9–12 per side, flat above, prominulous beneath, beautifully and regularly arcuate-ascending, not anastomosing but ending at the margins which they subparallel for a short distance; veinlet reticulation very abundant, conspicuous, plane or very slightly subprominulous above, prominulous beneath, with numerous subparallel tertiaries; inflorescence axillary, much shorter than the subtending leaves, cymose, usually 4-flowered, mostly about 4 cm. long in all; peduncles filiform, about 2 cm. long, nigrescent, glabrous; bracts absent; bractlets setaceous, minute; pedicels filiform, 3–7 mm. long, nigrescent, glabrous, flattened; calyx campanulate, nigrescent, 3–5 mm. long, 3–3.5 mm. wide, glabrous, its rim subtruncate, very shortly 5- or 6-apiculate-dentate; corolla white, hypocrateriform, its tube broadly infundibular, about 1 cm. long, about 7 mm. wide at the apex, densely cinereous-puberulent with microscopic hairs on the outside, the limb almost 1.5 cm. wide, 5-lobed, the lobes about 5 mm. long, acute; stamens 4, didynamous, included; pistil included, glabrous; style glabrous; stigma deeply bifid.

The type of this species was collected by Paul Alfred Petelot (*no. 6801*) in an open forest at about 500 m. altitude on Mount Bavi, province of Santây, Tonkin, French Indochina, on April 16, 1941, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Verbena hatschbachi Moldenke, sp. nov.

Herba parva; caulibus gracillimis tetragonis puberulentis; ramulis adscendentibus gracillimis acutiuscule tetragonis puberulis; foliis decussatis; petiolis gracilibus parce strigillosis marginatis; laminis membranaceis ovatis pinnatifidis, lobis 3 vel 5 et 2–3-lobulatis, lobulis prope apicem denticulatis, utrinque parce strigillosis; inflorescentiis terminalibus spicatis abbreviatis; pedunculis subfiliformibus acute tetragonis albo-puberulis.

Small herb; stems very slender, tetragonal, puberulent, rooting at the nodes; branches ascending, very slender, rather acutely tetragonal like the stems, puberulent with more or less upwardly curved hairs; nodes annulate; principal internodes 1–4.5 cm. long; leaves decussate-opposite; petioles slender, 3–5 mm. long, sparsely strigillose, margined; blades membranous, bright green on both surfaces, ovate in outline, 6–16 mm. long, 6–20 mm. wide, pinnatifid into 3 or 5 lobes, each lobe often again 2- or 3-lobed, the lobules often with 1 or 2 small teeth near their acute apex, sparsely strigillose on both surfaces; midrib and the 2 or 4 secondaries filiform, often obscure on both surfaces or sub-impressed above and slightly prominulous beneath; veinlet reticulation indiscernible on both surfaces; inflorescence terminal, spicate, abbreviated, the floriferous portion subcapitate when young, elongating to 2 cm. in fruit; peduncles very slender or subfiliform, 1–4.5 cm. long, acutely tetragonal, whitish-puberulent with somewhat antrorsely curved occasionally gland-tipped hairs; bractlets lanceolate, about 5 mm. long and 1 mm. wide, attenuate-acute at the apex, often purplish, white-ciliate along the margins, otherwise glabrate; calyx 4–5 mm. long, purplish, 5-ribbed, white-ciliate on the ribs, otherwise glabrous, its rim unequally 5-apiculate; corolla hypocrateriform, violet, its tube barely equaling the calyx, its limb about 3 mm. wide, densely puberulent on the outside.

The type of this species was collected by Gert Hatschbach (*no. 1621*)—in whose honor it is named—along the road from Rio Taquari to Rio Divisa, in the municipality of Piraquara, Paraná, Brazil, on November 13, 1949, and is deposited in the Britton Herbarium at the New York Botanical Garden.

Orchid Notes

1. A New Species of Gomesa R. Brown from Colombia

A. D. Hawkes
(*N. Y. Botanical Garden, New York, N. Y.*)

Gomesa erectiflora A. D. Hawkes, sp. nov.

Herba parva, epiphytica; pseudobulbi caespitosi, ex rhizome repente vel adscendente emergentes, verruculosi et sulcati, sylindrici usque ad ellipsoidei, leviter arcuati; folia solitaria, erecta, coriacea, ovato-lanceolata usque ad lineari-lanceolata, ad apicem bilobata, leviter conduplicata, ad basim attenuata; inflorescentia erecta, pauci- vel multiflora; bracteae scariosae, trianguli-ovatae, acutae vel leviter acuminatae; pedicelo erecto vel arcuato; flores mediocres; sepalum dorsale cucullatum supra columne, ovato-lanceolatum vel lineari-lanceolatum, acutum; sepala lateralia pendentes infra columne, linearo-lanceolata, acuta vel acuminata; petala cucullata supra columne vel pedentes, ovata, acuta, ad marginem undulata et pellucida; labellum fortiter pendens, ligulato-lanceolatum, ad apicem obscure bilobatum; columna arcuata.

Dwarf epiphyte. Pseudobulbs densely clustered, on a repent or slightly ascending rhizome which is more or less covered by deteriorating sheaths of brownish-grey color; pseudobulbs 2–3 cm. long, 3–8 mm. thick, verruculose and furrowed when dry, cylindrical to ellipsoidal in shape, sometimes slightly curved, laterally compressed, monophyllous, subtended by several foliar scarious linear-lanceolate acute sheaths. Leaves solitary, erect, coriaceous, ovate-lanceolata to linear-lanceolate, obliquely and obtusely bilobate at apex, rather conduplicate, narrowing toward base, 6.5–8.5 cm. long, 7–12 mm. broad. Inflorescence basal, solitary, rigidly erect, slender, 10–14.5 cm. high, with 5–8 flowers, sometimes secund; bracts sacrious, triangular-ovate, acute or slightly acuminate, ca. 4 mm. long and 1 mm. broad, hyaline when dry. Pedicels erect or arcuate, slender, to 16 mm. long. Flowers thin in texture, yellowish-brown when dry, 10 mm. long and 8 mm. broad when expanded. Dorsal sepal usually cucullate with the petals over column, ca. 5 mm. long and 1 mm. broad, ovate-lanceolate or linear-lanceolate, acute. Lateral sepals pendent with the lip below the column, 6 mm. long and 1 mm. broad, linear-lanceolate, acute or acuminate, usually slightly out-turned at the apex. Petals either cucullate with dorsal sepal over column or spreading and slightly ascending, ovate, acute, undulate on edges, 5 mm. long and 1.5–2 mm. broad, hyaline marginally. Lip strongly pendulous or slightly thrust forward, ligulate-lanceolate, obscurely bilobate at apex, 5 mm. long and 1 mm. broad. Column arcuate, 1.5–2 mm. long.

TYPE: *Lehmann 9997*, collected at Silvia, Central Andes of Popáyan, 2400–2600 m., Colombia. A second specimen, *Lehmann 3616*, collected in February, 1884, at Paisbamba and Coconuco, Central Andes of Popáyan, 2000–2500 m., is also referable to this species. Both sheets are deposited in the herbarium of the New York Botanical Garden.

Gomesa erectiflora is an attractive little orchid, apparently not closely allied to any previously detected species of the genus. It is of particular interest in that it represents the first occurrence of the group in Colombia, at least to this writer's knowledge.